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PLANNED SCIENCE OR GOVERNMENT PHILANTHROPY?

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I AM glad to accept the invitation of the editors of THE AMERICAN NATURALIST to contribute a few lines on the recent science legislative proposals, particularly about S.1720. This is the revised version of the original Kilgore and Magnuson bills, and was introduced into the Senate on December 21, 1945, by Senators Kilgore, Johnson of Colorado, Pepper, Fulbright and Saltonstall, and referred to the Committee on Military Affairs (is Minerva going to take Mars as her lawful, wedded husband?).

In the winter issue of the *Bulletin of the American Association of University Professors*,[1] I had the opportunity to comment on the original Magnuson-Kilgore bill. At the same time Lord Brabazon of Tara,[2] Minister of Aircraft Production in the Churchill Cabinet, himself a pioneer in aeronautics, published a letter on the freedom for scientific research in the British magazine *Nature*. These publications, both critical of propositions "of planning" fundamental research, expressed apprehensions as to the effect such science legislation may have directly or indirectly. The readers of THE AMERICAN NATURALIST may forgive me if I discuss the S.1720 in the light of this apprehensive but not unfriendly attitude.

I agree with Lord Brabazon and trust that many of your readers will agree with him too, that any attempt to plan fundamental research or to instruct any one as to what they are to study, *ipso facto* imposes *ad hoc* research upon scientists. The Senators and the scientists favoring S.1720 undoubtedly deny that the bill has any such intentions. The point at issue is not whether or not the authors of the bill desire scientific orthodoxy or regimentation of science along certain utilitarian lines. Granting that it is their honest conviction that no such thing will occur after the enactment of this bill, human nature, the uncertain times and the changing political and economic philosophies may put this bill to a use not intended by its sponsors and supporters.

One must admit that S.1720 is a great improvement over S.1297 (Kilgore bill) and S.1285 (Magnuson bill). The new bill no longer states in the preamble that the National Science Foundation is to promote a *national* policy for scientific research and education ("the horrible threat that science was no longer to be international has been protested against, very rightly, by all that is best in the United States, Britain and elsewhere"—Lord Brabazon). It is no longer stated that scientific research is to be *initiated* and *prescribed for* by the foundation. It states more modestly that the bill is to promote the progress of science and the useful arts, to secure national defense and to advance national health and welfare. It proposes to accomplish that by entering into contracts or other arrange-

[1] Theodore Koppanyi, *Bulletin of the American Association of University Professors*, 31: 681, 1945.

[2] Lord Brabazon of Tara, "Freedom for Scientific Research," *Nature*, 156: 746, 1945.

ments with organizations for the support of research and development activities. At least 15 per cent. of the sum appropriated by Congress for the foundation must be spent for research in national defense and the same amount for research in public health and medical sciences. Not less than 25 per cent. of the money to be appropriated must be apportioned among the States in their tax-supported and land-grant colleges and universities and an additional 25 per cent. in other, non-profit organizations. Each individual institution will retain, according to the bill, the widest latitude in its choice of research and development projects.

So far, so good. As I have previously stated, the appropriation of money by the Government should be impersonal and should go not to individuals but to institutions which in the past have demonstrated their willingness and ability to produce research as evidenced by publications in reputable national scientific periodicals. If it is established that there is a danger of exhaustion of private funds for research, there is no objection to the Government's stepping in to subsidize universities and research laboratories to enable their personnel to continue their research activities. This would eliminate the always unpleasant controversies of the merits and demerits of individual research projects. The administrator and his advisory committees should not be put in the highly embarrassing position of having to pass judgment upon the ability of their colleagues in the field and should not be given the power to make or break budding, or even unpopular mature, scientists. I also argued that "the men at each university or laboratory know each other best and it should be presumed that they are the best judges of what each man in his milieu could do with his test tube or Bunsen burner."

It may be presumed, and presumed unfortunately, however, that in addition to the money appropriated to institutions a large reservoir of funds will be available for individual scientists. In this connection I want to put in a frank and, under the circumstances, a brave word. It would be a highly undemocratic and unscientific situation if the practices adopted during the war were to be continued and the Office of Scientific Research and Development were to survive under the new name of National Science Foundation. I am not criticizing the achievements of the Office of Scientific Research and Development. It has done a marvelous job, very effectively and very expensively. It was justified by a national emergency. However, even then it was true, and I am quoting the former British Minister of Aircraft Production, that "the idea that there should be two classes of men of science, one knowing Government secrets and research work, and those outside the sacred fold, was, and is, a very shocking proposal." He might have also stated that it is equally shocking not to be included among the favored ones of a Government agency. Let us have none of this in the future.

As I see it, the whole situation boils down to this. Government philanthropy to support needy universities and research laboratories without any strings tied to it except a strict accounting and public statement of the money expended is fine. To grant scholarships and fellowships to deserving but poor young men and women is superfine. Planning fundamental research either by positive direction or by elimination or discrimination of undesirable people or projects or even the possibility of such a thing occurring in the future, is not so fine. And I believe that no committees are needed to judge the research men of America but that a National Science Foundation, if one is desired, should confine its activities to the study of university and similar budgets and needs. The Army and Navy will take care of research for national defense. At least that is what I recently read in the papers. Applied research, which the bill calls "development project," can and should indeed be planned, but the

older Government agencies and the industries can amply take care of such planning.

Let us close this argument with the fine words of Lord Brabazon, which I trust we all agree upon: "We must appreciate that the pure scientist is a creative artist. No one must boss him. No one drive him. We are lucky in the production of these great men. Certainly arrange that their lives be free of monetary worries, but let us remember that their life interest and pleasure is research, and leave them to carry on undisturbed by the stormy blasts and distractions of a world licking its wounds and quarrelsome after a protracted fight. Do not of all things plan their lives. Some will produce future miracles no doubt, but most perhaps may not be so lucky. That should not worry us; our duty is to have given them the chance, and although many of their names may not be handed down to the future praised by all, yet they will have done good and noble work, for which we should all be no less grateful."

TEN UNMET CHALLENGES OF PUBLIC HEALTH[1]

By Dr. C.-E. A. Winslow

1945 Recipient of the Prentiss Award; Professor Emeritus, Yale University

I am grateful for the kind things said of me by my old friend, President Angell, who has been more lenient with me than he often is in introducing a helpless speaker. I deeply appreciate the honor which the Cleveland Health Museum has conferred upon me to-day; and the fact that this honor is undeserved makes it, of course, all the more gratifying. All that I have contributed in the field of health aducation is to point out certain things that might be done—things which have, later, been accomplished by others. It is the Routzahns and Bauer and Gebhard and Hiscock and Turner and Rickards and Peter and Ruth Grout and Lucy Morgan who have the credit of real accomplishment. I did initiate perhaps the first health exhibits in this country at the American Museum of Natural History in New York in 1910 and our giant models of the typhoid fly and the plague flea may compare not unfavorably with some of Dr. Gebhard's beautiful displays in Cleveland. I did develop what I think was the first organized division of health education—in the New York State Department of Health in 1915. But in the field of public service, it is *not* the first step which counts, nor the last step at any given moment; but the spirit of continued and accelerating progress—such progress as the Cleveland Health Museum typifies to perfection.

I am here then as a prophet, not a performer in health education, and I propose to continue the relatively easy role of prophecy this afternoon and review very briefly with you some of the outstanding unmet challenges of public health and some of the recent recommendations and legislative proposals which have been made to meet them.

I am assuming the continuation and expansion of all the major lines of health service which are now functioning actively and efficiently. I take for granted that we shall go forward steadily with the protection of our physical environment by sanitation; with the suppression of acute epidemic diseases; with our programs for the control of tuberculosis, syphilis and gonorrhea; with the evolution of a comprehensive generalized public health nursing service for all areas; and with a well-organized program of education in nutrition.

Making these assumptions, I see the following ten fields of health service, as offer-

[1] Address delivered at the Fifth Annual Civic Luncheon, Cleveland Health Museum, on the occasion of the presentation of the Prentiss Award to Dr. Winslow.

ing the most vitally challenging opportunities of the first post-war decade.

1. It is obviously essential that we should extend our standard administrative public health services to cover the semi-urban and rural areas which now lack adequate local health protection. Dr. Haven Emerson points out in a recent report to the American Public Health Association that 40 million people now live in areas which have no organized local health service. If, in place of some 18,000 administrative health units —most of them now staffed on paper only by part-time, untrained health officers—we had 1,200 units of size adequate for efficient operation, a basic minimum of health protection could be provided and at a cost of only one dollar per year per person served.

2. At the right hand of the official health department stand the voluntary health agencies, the visiting nurse associations, the tuberculosis associations and the like. The voluntary health agency is one of America's most significant contributions to the public health program. Freedom and initiative give this type of agency its unique value; but the conflicting demands of agencies, each of which is concerned with a special disease or a special period of life, creates confusion in the public mind and leads to fantastic inequalities in the distribution of funds. A recent report by S. M. Gunn and P. S. Platt, prepared for the National Health Council, outlines sound policies for increasing the effectiveness of the individual voluntary agency by improving the efficiency of its paid executive and directing Board; and makes a strong plea for coordination of the work of the various voluntary agencies and cooperation in the joint solicitation of funds for the common cause of the people's health.

3. We need a more unified and more comprehensive program of child welfare. In the control of the physical health hazards of maternity and infancy we have achieved notable results; but the emotional hazards of these life phases have been neglected. The unfortunate school child is too often a bone of contention—or a no-man's land—between the Board of Health and the Board of Education. If a nurse tells you "We have no trouble with the school people. We can always get our problems cleared up," she is talking not about cooperative planning but adjustment of grievances. The revelations of the Selective Service examinations have, at last, shocked us out of our state of complacency as to accomplishments in this field. It is true that defects which unfit a young man for combat duty may not handicap him seriously in a sedentary civilian life. It is true, also, that certain defects are of a nature which we cannot remedy. There is, however, enough in the draft findings to make it clear that our school health program has failed to cope with a multitude of physical and emotional handicaps which could and should have been materially reduced by competent supervision. What we really need, in every state and every local area, is a Council on Childhood, to coordinate existing machinery in health, welfare, education, recreation and the like and to develop a vital and complete program for building the young America of the future. It is gratifying to note that a national organization, Spokesmen for Children, has recently been organized with these ends in view.

4. The basis of our whole program for health in a democracy must be community education; and this involves not merely the preparation of educational material. Such material is like strategic bombing which prepares the way; we need infantry, actually to occupy the land of ignorance and inertia. Only a community health educator in each local area can effectuate the teaching of health principles by the organization of community groups, ready to act at each appropriate moment for the support and extension of needed health facilities.

5. The greatest of all unmet needs in the health field is the need for medical care; and the urgency of this need is emphasized by our effective control of the communicable diseases of childhood and youth which has

resulted in an older population with increasing relative importance of diseases like heart disease, cancer and diabetes in which prompt medical attention is of major significance. We have a more ample supply of doctors, dentists, nurses and hospitals than any other country on the globe. Yet those in the lower half of our population from an economic standpoint get less than half the medical care they need. There is but one way in which this care can be provided (short of state medicine, which is practiced in Russia but has no serious advocates in this country); and that is prepayment of medical costs through expansion of our national compulsory insurance system. President Truman on November 19, in his message to Congress on a national health program outlined a sound and statesmanlike approach to this problem. Only along the general lines laid down in that message can the problem be solved.

6. We need in every community in the United States far greater facilities for the institutional care of two classes of cases, the convalescent and the chronic, which do not need the costly facilities of a general hospital but cannot receive the attention they require in the average home.

7. We have scarcely made a beginning in our attempt to cope with the evils of dental disease. Fluorine may help as a preventive; and inclusion of dental care in a comprehensive prepayment plan would provide for routine attention. Very special efforts must be made, however, to increase the volume of corrective work done for the school child so that the young adult may not arrive at maturity with his dentures in a condition of advanced decay.

8. The housing of our people will be a major element in the health program of the future, since a decent home is basic in physical, emotional and social health. To attain this objective will require continuation and expansion of our Federal low-rent housing programs along lines laid down in the Wagner-Ellender-Taft bill now before Congress.

9. Nearly half of the beds in all our hospitals are occupied by patients suffering from mental and nervous diseases; and the burdens placed upon the average family by the doubts and fears and resentments and insecurities from which you and I suffer are equal in volume to all the burdens placed upon us by so-called "physical" disease. Mental hygiene is not a small sector of the total health problem but more nearly half of it; and it should be woven into nearly every one of the other nine objectives which we discuss to-day. We need more psychiatrists (who are also mental hygienists) more child guidance and behavior centers and mental hygiene clinics, more enlightenment on the part of the family doctor, the nurse, the teacher, the social worker and the parent, who must all be in the firing line in the war against mental disease.

10. Finally, in the next months we shall be building the framework of the United Nations a new organization for International Health, to carry on the fine work which was performed in this field by the Health Section of the League of Nations.

Health, in the ancient Anglo-Saxon from which this word derives, means "Wholeness." We must deal not with one age-period or one disease or with one country. Health in its fullness,—health, mental as well as physical—health for all the men and women and children in all the countries of the world is the goal for which we strive.

DR. THOMAS BARBOUR

(Photograph on Front Cover)

WITH the death of Dr. Thomas Barbour on January 8, 1946, American and world biology, and especially zoology, suffered a very severe loss, and the institution with which he was officially connected since 1910, an irreparable one. His death, which was due to cerebral hemorrhage, was not wholly unexpected, for he had suffered for several years from heart trouble. Born on August 19, 1884, it is most regrettable that he should have reached the end of his career at a relatively early age, for he had not attained his sixty-second birthday. Whenever a dynamic productive individual such as Dr. Barbour was passes from our midst, the loss is great. He possessed that rather rare combination of being not only an able administrator, but also a research scholar. There was so much to be done, and so many tasks that he wished to finish for which he was so eminently fitted by education, experience, accumulated knowledge, personal interest, inclination and innate abilty, it is regrettable that he could not have been spared for further productive work.

He has given us an excellent summary of many of his very numerous experiences in various parts of the world, his ambitions and accomplishments, in his particularly well-written book "Naturalist at Large," and it is scarcely necessary to repeat in this brief sketch the data that are included therein. The son of wealthy parents, he elected, at an early age, to follow zoology as a profession, and for many years served as one of those numerous voluntary servants of Harvard University who have done so much for the institution and for themselves in their special fields. His "salary" from Harvard University was never more than a token payment, and he annually contributed large sums from his personal income for the support of this or that activity in which he was interested, particularly the Museum of Comparative Zoology. As an individual with reasonably ample means he utilized this income liberally and judiciously in furthering the ends of the institution with which he was constantly associated from 1910 and which he directed from 1927, he, as Director, being fourth in line from Louis Agassiz, who founded the institution. But his largesse was by no means confined to the museum, for he liberally supported other institutions, some remote from his own particular field of interest. He was one of the small group that became interested in the establishment and support of the Barro Colorado Station in Gatun Lake, Panama, contributed extensively to the development of the Atkins Institution of the Arnold Arboretum, near Cienfuegos, Cuba, of which he was Custodian, an activity that naturally brought me in rather close contact with him, and even extended his interests to the Arnold Arboretum itself. Another local institution that benefited from his attention was the New England Museum of Natural History, of which he served as President from 1925, this being, of course, a natural interest on his part. Entirely outside of his special interests as an outstanding zoologist, he served his terms as a Trustee of Radcliffe College, and of the Carnegie Institution of Washington, and as a member of the Advisory Board of the Guggenheim Foundation; while at Harvard University his influence was felt as a member of the Council of the University Library and as a Syndic of the University Press. His interests in the wider field of biology were catholic, and his knowledge of details, even in fields beyond those of his special interests, distinctly remarkable.

In the support of institutions and in projects in which he believed, and in which he had confidence, he was not only liberal within his means, but what is better, intelligently liberal. Many enterprises are now in a better position than could possibly have been the case but for the support and

encouragement extended by him. He was essentially a naturalist, his own particular field being herpetology. Because of his personality, his high attainments and his surprisingly intimate knowledge of many diverse and often unrelated fields, he was a most delightful individual with whom to associate, whether this be in his home (and I judge that there was seldom a dull moment in the Barbour family), in his office, in his famous "eateria" associated with his office where he entertained his own coterie of intimate friends, not infrequently with strange foods, or as a traveling companion. On field trips he could and did make illuminating observations on such diverse subjects as herpetology (his prime interest), mammals, birds, fishes, insects, crustaceans, shells, and other groups of animals, as well as in paleontology and even botany. Although he was a zoologist he had a surprising knowledge of the technical names of plants. Here, of course, an unusually retentive memory served him well, for at sight he could call the name of an extraordinary wide range of organisms, plant or animal, at will, and with surprising correctness.

Dr. Barbour's honors were many and distinguished. Graduated from Harvard University in 1906, he returned to that institution for his Master's and his Doctor's degree, receiving the Ph.D. degree in 1910. It is clear from his own writings that he deliberately selected Harvard University for his undergraduate and graduate work because even as a young man he knew exactly what he wanted to do in life, and because of the unique facilities of the Museum of Comparative Zoology of which he became Director in 1927, and which, as he often stated, is a naturalist's or a working institution, rather than a display museum. He had previously served as curator of reptiles from 1910. In the academic field he was also the recipient of the Sc.D. degree from the University of Havana (1930), Dartmouth College (1935), Harvard University (1939) and the University of Florida (1944). Among the numerous domestic and foreign societies that have honored him, and themselves as well, by selecting him to membership, are the American Academy of Arts and Sciences, American Philosophical Society, National Academy of Sciences, Royal Asiatic Society, Royal Geographic Society, Linnean Society and Zoological Society of London, the Nederlandsche Dierkundige Vereen.

His grandfather came from northern Ireland, and thus, like most members of his race, Dr. Barbour was endowed with an unusually keen sense of humor, as all will realize who were personally acquainted with him, or the wider circle that are familiar with his "Naturalist at Large" and other volumes of this type. He was a past master at recounting his experiences and observations, and even when the joke was on him, nobody could possibly appreciate it more than he. If he differed from some one regarding this or that proposed solution of a problem, he was by no means the type who would refrain from expressing his opinion, even if it might be an adverse one. He could be depended upon to say exactly what he felt, and what he thought about this or that problem, and he had the faculty of trenchantly expressing his ideas.

On the occasion of my last long trip with him in Florida several years ago, we made a special pilgrimage to Key West. One of the chief objectives of the trip was a search for turtle steaks which were to be taken to a small hotel on Great Pine Key where the cuisine was excellent, and where the proper treatment of turtle steaks and the preparation of Key lime pies was a highly developed art; for Dr. Barbour knew and appreciated good food. I can still remember his emphatic expression when, in Key West, we were confronted with a sign over a small restaurant which read "Turtleburger sandwiches" . . . we didn't try them, but we did get the turtle steaks which were later properly served with Key lime pies! But the "turtleburger sandwiches" were not for us.

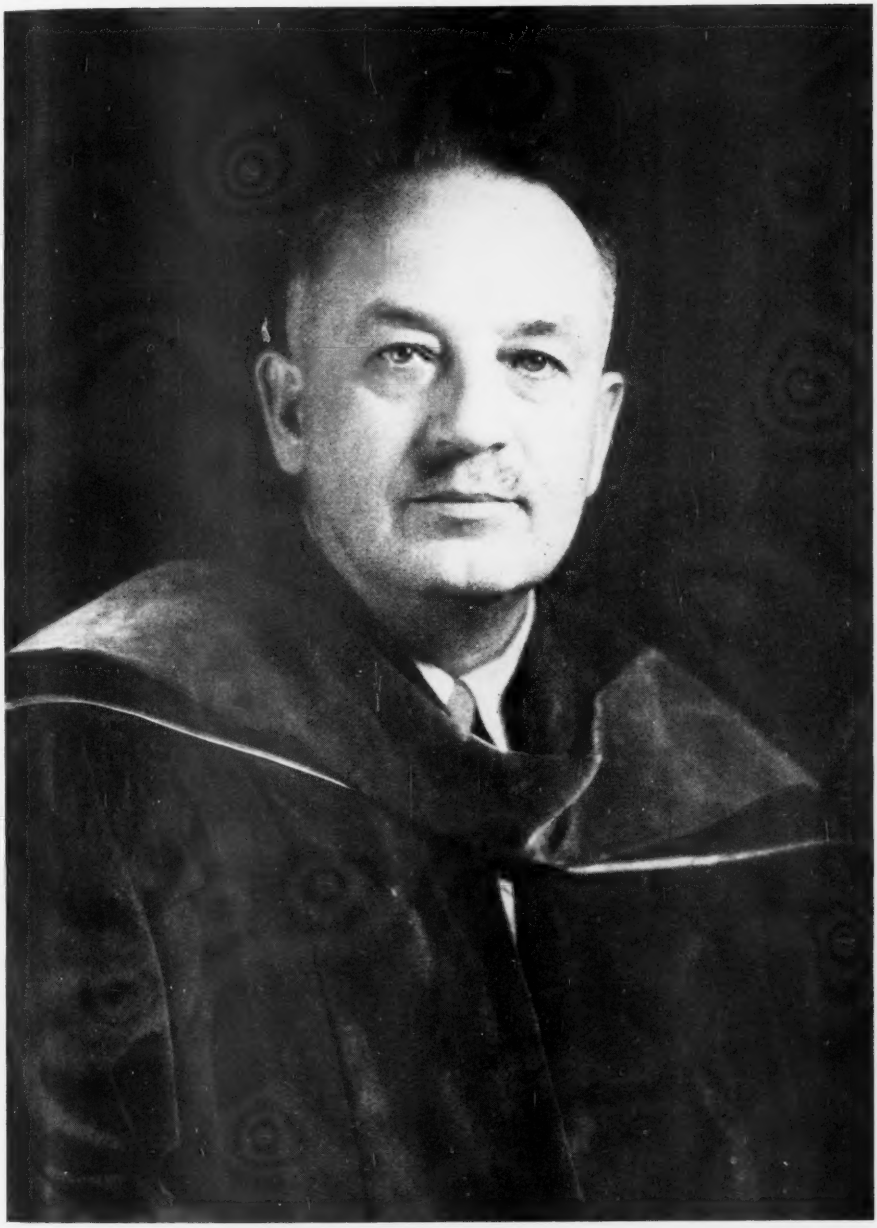
Returning to Coconut Grove we proceeded across the Everglades to the Ten Thousand Island region, where we enjoyed the fishing for a few days and later proceeded northward leisurely to the lake country of central Florida, and finally to the east coast, where I took the train for the north. A few days after my arrival in Boston I received a package from him, and on opening it I found myself in possession of a unique copy of "Scenic Florida." This was a beautifully illustrated brochure to stimulate the tourist trade. Admittedly, for publicity purposes, some of the color prints were liberally adorned with various bathing beauties. The uniqueness of my copy was in the revised title page, in sonorous Latin, which Dr. Barbour had dashed off, reading: *Catalogus illustratus tendicularum catostomorum* . . . . I refrain from quoting the whole of the original, but translated it was: "An illustrated catalogue of the sucker traps to be seen in the state of Florida, today for the most part dedicated to the exposition of the bodies of most beautiful Florida girls, particularly those who swim and fish." I must admit that at first I was a bit puzzled by the title, until I realized that the word "eastostomorum" was taken from the generic name of a group of fishes known as the suckers (*Catostomus*), and then T. B.'s classification of these tourist attractions flashed into my mind; to him they were all "sucker traps" or "*just* sucker traps," there being a subtle distinction in that the former were actually worth the price of admission, but the latter were not!

Dr. Barbour was an individual of striking personal appearance. With a height of six feet five inches, and proportionally stout, for he weighed in excess of three hundred pounds, he commanded attention in any gathering. He had his own ideas and did not hesitate to express them; but his conclusions were usually well taken, for his judgment was excellent. He was emphatically the type of individual the Spaniards designate as *simpatico*, and this character stood him in good stead in his extensive dealings with Latin-American peoples. He was intensely interested in the natural history of Cuba and other parts of North and South America, Cuba being one of his first loves, and with which he was intimately familiar from his numerous trips there. His relationships with resident Cuban naturalists were very close; here, of course, an intimate knowledge of the Spanish language served him well. The interest and stimulus were mutual and reciprocal. As one of the leading Cuban naturalists recently expressed it to me on learning of Dr. Barbour's death: "We Cubans loved Doctor Barbour." He was sympathetic with, and helpful to all workers in the complex field of zoology, particularly so with beginners. His mastery of the English language was unusually good, and many young men benefited from his advice in the preparation of technical papers, for he was exceedingly patient in pointing out how this or that part could be improved in form and diction; and I happen to know that his skill in presentation was not confined to assisting young zoologists, for even botanists and foresters were, on occasion, indebted to him.

Dr. Barbour was the son of William and Adelaide (Sprague) Barbour of New York City. He was married to Rosamond Pierce of Brookline, Massachusetts, in 1906, who survives him. The other surviving members of his family are three daughters, Mrs. Mary Bigelow Kidder, Miss Julia Adelaide Barbour and Mrs. Louisa Bowditch Parker, and two brothers, Robert Barbour and Frederick K. Barbour.

E. D. Merrill

Arnold Arboretum
Harvard University



RODNEY BEECHER HARVEY

RODNEY BEECHER HARVEY

With the death of Dr. Rodney Beecher Harvey on Sunday, November 4, 1945, the world lost one of its outstanding plant physiologists. He died of a heart attack at the University of Minnesota Hospital after a very brief illness.

Born at Monroeville, Indiana, May 26, 1890, Harvey was educated in the public grade school and the high school of that village. It was natural that on finishing his high-school work he should enter Purdue University for more advanced work. He went to Purdue in 1910 and began work in pharmaceutical and food chemistry. From this work he was graduated as a pharmaceutical chemist in 1912. It was during these years at Purdue that he first became interested in plant physiology. Following his graduation he was appointed Assistant Botanist at the laboratory of the Eli Lilly Co., Inc., at Indianapolis. Here he found use for his previous training in drug inspection, sectioning drug plants and in making pharmaceutical preparations and microscopic slides of sectioned material. He also had the use of their excellent library and the stimulating fellowship of many research men in physiology, botany, and chemistry. He became a member of the American Chemical Society in 1912, and joined other national scientific societies serving his main interests.

Following this brief period at Indianapolis, he went to the University of Michigan in 1913, and became assistant in plant physiology to Dr. Frederic C. Newcombe, who was at that time an active and able investigator of plant tropisms. Early in 1915 the B.S. degree was granted him by the University of Michigan. At the end of the spring semester of 1915, he entered the University of Chicago, and began his work for the doctorate with Dr. William Crocker. Before the summer of 1915 had passed, he received an appointment as pharmacognosist in the U. S. Bureau of Chemistry, a position he held for only a short time, as he was transferred to work in plant physiology with Dr. Rodney Howard True in the Office of Plant Physiological and Fermentation Investigations in the Bureau of Plant Industry, the U. S. Department of Agriculture.

During the period from 1915 to 1920, under the guidance of Dr. True and Dr. Crocker, Harvey began his life work in plant physiology. His research took him into such diverse and broad fields as mineral nutrition of plants, salt absorption, permeability, enzyme activity, respiration and winter hardiness. He became thoroughly acquainted with many research instruments and methods, and published important contributions in all the fields mentioned. He returned to the University of Chicago as a fellow in plant physiology in 1917, and was awarded the Ph.D. degree in 1918, his thesis being on frost injury and the developments following freezing. As his work on winter hardiness attracted wide attention, he was invited to join the staff at the University of Minnesota in 1920. Here he became a great leader of research, and many students came to him for instruction and guidance. He had won promotions from time to time to a full professorship, and had just completed 25 years of service at Minnesota at the time of his death. During this extremely active period he published more than 200 contributions, and his interests covered the whole range of plant physiology. In 1939, the institution in which he received his first instruction in plant physiology, Purdue University, conferred upon him an honorary D.Sc. degree in recognition of his extraordinary service to science and industry.

One of the most valuable traits of Dr. Harvey was his keen sense of the practical value of his work. Hardiness studies meant methods of testing varieties for

hardiness, winter resistance of all kinds of crop plants and selections from a variable population of cold-resistant races. Again, the physiological activity of ethylene was turned to the ripening of bananas, tomatoes, honeydew melons and other fruits, to the earlier and more uniform coloring of ripe but green-colored citrus fruits, to the blanching of celery, etc. He used x-rays for inspecting fruits and vegetables for internal defects and diseases; he developed processes for fruit preservation and sterilization; waxing of fruits to lower transpiration and improve shipping quality; and used waxed paper and cellophane wrappers to prevent spoiling fruits from injuring the flavor of neighboring fruits. A number of these processes received favorable consideration for patents, and some of them have attained world-wide use. At the time of his death he was working on hormonal weed eradicants, after having devoted some years to the use of poisonous chemicals in weed control. So his imagination and genius moved back and forth between the fundamentals of science and the practical application of principles to specific needs.

His interest in plant physiology and the welfare of plant physiologists was vital. In the latter part of 1923 and early months of 1924 he began the work of organization which culminated in the establishment of the American Society of Plant Physiologists. He was the leading and guiding spirit who saw the need most clearly, did all the preliminary work necessary to organization, compiled the society's first constitution and carried out the first election under the constitution. In this election he was himself elected first secretary-treasurer of the new organization, and gave a year of spare time to encouraging its growth. Later he was vice-president, and in 1936-1937 he was elected president of the society, which in the meantime had grown into a strong and healthy body of about 500 members.

He was largely responsible, also, for the formation of the Minnesota Academy of Sciences, an active organization which now numbers five to six hundred members, and of which he served as president in 1942-1943.

He spent the year 1927-1928 abroad, as a Fellow of the John Simon Guggenheim Foundation. In this capacity he studied at the University of Cambridge with Dr. F. F. Blackman, of the School of Botany; and at the Low Temperature Research Station with Sir William Hardy, Professor Franklin Kidd and Professor Cyril West. He also spent some time at the University of Bonn with Dr. Ernst Schaffnit, and at Leningrad with Dr. N. A. Maximov. He was commissioned by the Guggenheim Foundation to make a survey of research in progress in the agricultural experiment stations throughout Russia.

In 1936-1937 he was Director of the Florida Research Laboratory at Dunedin, Florida. This laboratory was founded to conduct research on fruit processing in connection with industrial and state institutions. To this work he brought his rich experience and broad knowledge with great success. He made other industrial connections at various times, as with the Food Machinery Company, Inc., Pacific Coast Distributors, United Fresh Fruit and Vegetable Association, Carbide and Carbon Chemicals Company, The United Fruit Company, Koppers Coke Company, American Potash Institute, The American Cyanamide Company, and other industrial concerns. His expert knowledge was applied to the extension, improvement and practical use of the commercial processes he had initiated. During 1942-1943 he was Director of the Division of Industrial Microbiology of General Mills, Minneapolis, Minnesota.

He was the author of three books on plant physiology: "Plant Physiological Chemistry," 1930; "A Text-book of Plant Physiology" (with A. E. Murneek) 1930; and an "Annotated Bibliography of the Low Temperature Relations of Plants,"

1935. He maintained this index of literature on low temperature relations to the very end, and it is one of the most complete and valuable bibliographies ever compiled. A fourth text-book entitled "Technology of Fresh Fruits and Vegetables" was ready for publication at the time of his sudden death. It is a comprehensive treatise in three volumes, intended for students of food technology and for the trade.

Even Dr. Harvey's hobbies concerned the field to which he had given his life. He studied and collected historically valuable works on plant physiology, and he had made a most interesting collection of portraits of plant physiologists. This collection includes approximately five hundred portraits of research men, photographs of historically noted laboratories, and groups of students of historical interest. Unique among these portraits were sixty-seven drawings by the noted Russian artist, Streblov. These were life-size portrait busts of plant physiologists. On a few rare occasions some of these portraits were placed on exhibition at scientific meetings, and always attracted great attention and admiration.

He also kept the addresses of plant physiologists throughout the world, and these were published several times by the American Society of Plant Physiologists as an International Address List, a most valuable service.

Harvey was a member of many organizations besides those already mentioned, among which are the American Association for the Advancement of Science (Fellow), Botanical Society of America, American Phytopathological Society and the Ecological Society of America. He was also a corresponding member of the Botanical Society of Czechoslovakia.

On June 17, 1916, Dr. Harvey married Helen M. Whittier, who survives him. They had five children, one of whom, Hale M. Whittier, died at an early age. The living children are Rodney Bryce, Rhoda Beatrice, Helen Elizabeth and Eleanor Whittier. The home life of the Harvey family was marked by a practical idealism, and there was a tender bond of sympathy between each member of the family and all the rest.

Dr. Harvey's life and work have been of inestimable value to plant physiologists and to plant science generally throughout the world. He lives on in the work he left accomplished, and in the lives of the great numbers of students who received a part of his spirit. All men are indebted to him for the valuable contributions he made to the common welfare through the practical results of his research. He is mourned by his colleagues, students and friends, who are legion. Of men of such stature as he, it is no less true than of statesmen, surely, that, as Markham beautifully and touchingly says it, in going he "leaves a lonesome place against the sky."

CHARLES A. SHULL

42 Oakwood St.,
ASHEVILLE, N. C.

ROBERT HAGELSTEIN

May 16, 1870 – October 20, 1945

ROBERT HAGELSTEIN, late Honorary Curator of Myxomycetes, The New York Botanical Garden, was born and educated in New York. In that city he engaged in an active business career, retiring from the management of a mercantile house twenty years ago to devote his full time and energies to science.

Before World War I he was actively associated with the Department of Microscopy of the Brooklyn Institute of Arts and Sciences and later with the New York Mi-

Photo by G. F. Weber, Gainesville, Fla.
ROBERT HAGELSTEIN

croscopical Society, serving as president of the latter organization in 1923 and 1924. He also formed active affiliations with The New York Botanical Garden, The Mycological Society of America and the Torrey Botanical Club. In addition he belonged to the New York Academy of Sciences, the American Microscopical Society, the Royal Microscopical Society and the Quekett Microscopical Club.

Mr. Hagelstein made a thorough study of the microscope, in both its theoretical and practical aspects. After associating himself with the New York Botanical Garden he worked on the historical collection of old instruments belonging to that institution, rearranging the exhibit and publishing a descriptive list of the microscopes.[1] For many years he studied and collected the diatoms of Long Island, New York. In 1926, 1928 and 1929 he made collecting trips to Puerto Rico to gather material for his study of the diatoms of that island. In the "Scientific Survey of Porto Rico and the Virgin Islands," published by the New York Academy of Sciences, he contributed the section on "The Diatomaceae of Porto Rico and the Virgin Islands," published in 1939.

[1] *Journal of The New York Botanical Garden*, 34: 9–13, January, 1933.

The myxomycetes were his major interest, especially in the last ten years of his life. His numerous contributions to this subject, commencing in 1927, culminated in the publication in 1944 of his book, "The Mycetozoa of North America, based upon the specimens in The New York Botanical Garden." In this book he incorporated the results of his years of study of this interesting group of organisms. His extended collecting trips from Florida to Canada, pursued intensively in Pennsylvania and Long Island, provided a vast amount of material that required long hours of daily study in the laboratory. In addition he made close microscopical study of the entire extensive collection at The New York Botanical Garden.

The large collections of diatoms and myxomycetes that he formed during his lifetime have been incorporated in the herbarium of the New York Botanical Garden. Here they continue to influence others to investigate these groups, an influence that during his lifetime was backed by his own magnetic personality.

JOSEPH F. BURKE

NEW YORK
BOTANICAL GARDEN

RESEARCH UNDER THE AUSPICES OF THE U. S. NAVY

A WIDE program designed to encourage scientific research in American educational institutions and industrial concerns, estimated to cost millions of dollars, has been introduced by the Office of Research and Inventions of the Navy Department and is described by Benjamin Fine in *The New York Times*.

Thirty of the country's colleges and universities have signed or are negotiating contracts which, in a sense, will put them in partnership with the Navy Department.

The fields include electronics, nuclear physics, biophysics, nutrition, radio, biology, material deterioration, chemistry, mathematics, flight, guided missiles and medicine.

Dr. Alan Tower Waterman, on leave from Yale University, has been appointed head of the scientific branch of the Research Office, effective on February 1, to supervise the research program. Its directors are Captain Robert Dexter Conrad, USN, for the planning division; Captain Donald L. Hibbard, USNR, for the special devices division, and Commodore Henry Adrian Schade, USN, for the Naval Research Laboratory.

Rear Admiral H. G. Bowen, chief of the Office of Research and Inventions, ex-

plained that two types of contracts were offered—consultative and general research. Under the former the Navy can call upon experts at the colleges to advise it on problems or to participate in special projects.

Describing the research contract as "a new departure" for the Navy, he stated:

"It is essentially a partnership agreement to conduct research in the sense that it is understood by most scientists—the creation of new knowledge. The tasks to be performed under such a contract will be specified only under the most general terms. Reports are to be submitted periodically."

Colleges will be permitted to publish the results of their work provided that no reference is made to possible or proposed military applications. The Navy will advise the institutions whenever they are in doubt as to wisdom of publishing material that might affect the national security.

"In carrying out our project we will help make it possible for colleges to train a great many young scientists. The draft caused a shortage of 17,000 technically trained men. Through our program that shortage can be in part replaced."

Institutions with which contracts have been signed or are under negotiations include:

California Institute of Technology, Carnegie Institute of Technology, Columbia, Cornell, Brooklyn Polytechnic Institute, Harvard, Princeton, Johns Hopkins, Massachusetts Institute of Technology, University of Michigan, University of Pennsylvania, University of Texas, Syracuse, Stanford, University of California.

In his statement Admiral Bowen said that the program was undertaken because the Navy recognized the value of these research centers as demonstrated by their war contributions of scientific personnel and laboratory facilities.

For research of interest to the Navy that would fit into a normal educational program funds would be provided to a contracting institution which would have "opportunity to use courageous imagination and freedom to make a fair percentage of mistakes." No fixed sum has been set for any branch of research. But a grant will largely depend on the nature of the work and the size of required personnel.

It was explained that selection of a participant was usually made on the basis of the known ability of its personnel in the field concerned and in the project proposed. A college administrator might submit a program and confer with the Navy chiefs; if his proposal appeared promising, a contract would be signed.

After a contract is made, the Navy will exercise little supervisory control. A contract would run for a year and then, if the project had not been completed, it could be renewed.

With particular emphasis put on medical research, the Navy is now considering several projects submitted by medical schools, and contracts in this field are expected within a month.

ARMY AWARD TO COLONEL LANMAN

COLONEL THOMAS HINCKLEY LANMAN, M.C., A.U.S., on leave of absence as a member of the Surgical Staff of the Children's Hospital and as assistant professor of surgery at the Harvard Medical School, was recently awarded the Legion of Merit by direction of the President. The citation reads as follows:

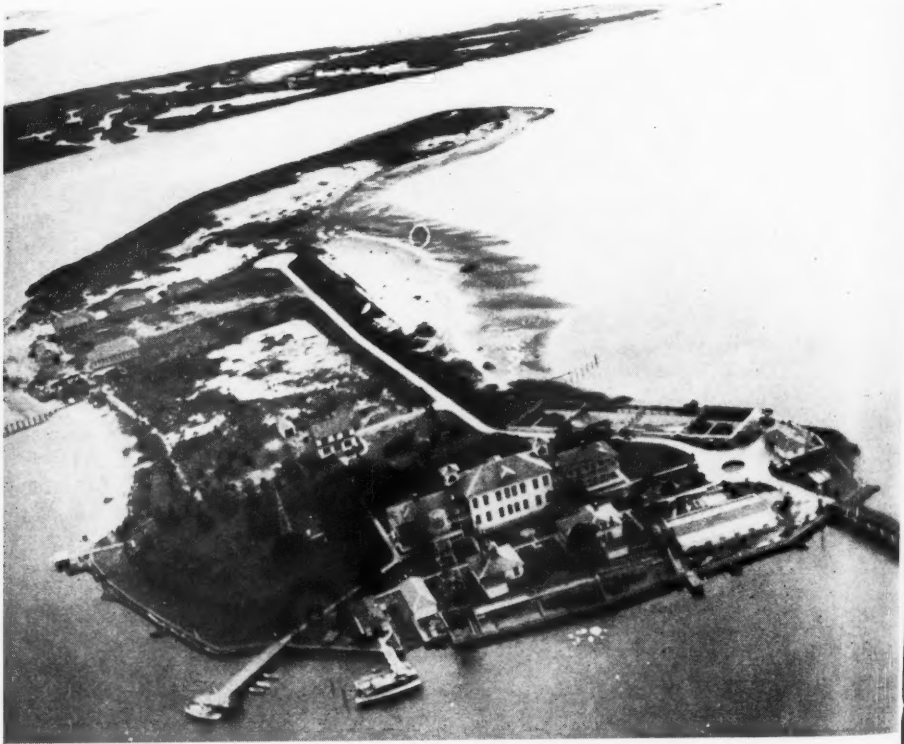
"For exceptionally meritorious service in the performance of outstanding service as surgical consultant for the 12th Hospital Center. Colonel Lanman displayed outstanding judgment, zeal and devotion to duty in directing the surgical policies for the care of thousands of battle casualties. This has resulted in the saving of life, in the prevention of serious complications and in shortening the time of incapacity."

THE U. S. FISHERY BIOLOGICAL LABORATORY

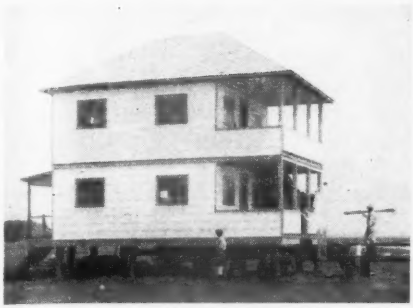
PLANS are now being prepared for the construction of a modern fireproof building to replace the old frame structures at the Beaufort Laboratory at Beaufort, N. C.

The present station was completed and opened to investigators in 1902 and is situated in the center of the greatest fish and shellfish producing county in the United States. It is now maintained by the Division of Fishery Biology of the U. S. Fish and Wildlife Service and is devoted to problems dealing with the maintenance and utilization of the fishery resources of the South Atlantic region. Although its chief purpose is to procure and disseminate biological and technological information of economic value to the fisheries, no opportunity to carry on pure research is lost, and the facilities of the laboratory are extended to investigators from universities and other institutions who are competent to conduct independent research.

The laboratory is ideally situated on a small island in Beaufort Harbor and connected with the mainland by a bridge and causeway. This provides desirable but not inconvenient isolation and assures quiet and pleasant surroundings for research work. In front of the laboratory may be seen breaking seas of the Atlantic Ocean, while to the east and west is an intricate system of waterways, islands, marshes and tidal flats lying at the mouths of the two rivers and two sounds connected with Beaufort



THE U. S. FISHERY BIOLOGICAL LABORATORY, BEAUFORT, N. C.



EXPERIMENTAL OYSTER FARM, NORTH RIVER, N. C.

Inlet. The prevailing southwest winds from the Gulf Stream maintain pleasant air and water temperatures for summer work and recreation.

The U. S. Fish and Wildlife Service is anxious to interest investigators from other institutions in problems that pertain to the conservation and proper utilization of the aquatic resources of the region, but at the same time, in so far as facilities permit, offers them entire freedom in the selection of such biological studies as they desire to make.

Recently, extensive improvements have been made to the buildings, grounds and equipment so that the laboratory is thoroughly modernized and open for investigations throughout the entire year. There is also an experimental and demonstration oyster farm which is situated near-by on North River where the brackish water conditions are favorable for the growth of marine plants and animals, and for conducting studies and experiments under natural conditions.

Dr. H. F. Prytherch, biologist in charge, would appreciate receiving ideas and suggestions from scientists concerning any special facilities or arrangements which should be considered in order that the new laboratory may adequately serve the future needs of our research men. He has been there now for fifteen years and he is anxious to develop another first-class modern laboratory.

WATCHHOUSE, FIELD LABORATORY AND PIER

PEKING MAN RETURNS TO CHINA

A REUTER's dispatch from Shanghai to *The Times*, London, states that the skeleton of the Peking Man, taken to Japan by the Japanese army as loot during the occupation, is to be returned to the National Geographical Survey of China.

The University of Tokyo is reported to have surrendered these priceless bones, together with implements and crude jewelry from a primitive age, to the Allied authorities in Japan. Japanese army scientists found the Peking Man in Peking after a three-year search, and specialists supervised its removal to Tokyo. Initial examination shows that none of the bones, utensils and personal adornments, charts or other documents accompanying the relics was damaged.

THE AMERICAN VETERINARY MEDICAL ASSOCIATION

THE American Veterinary Medical Association will seek contributions for a fund to support research in veterinary science. President Farquharson has appointed a special committee, on financing research under the chairmanship of J. U. Lacroix, the treasurer of the association, to inaugurate a campaign. As its first task, the committee hopes to collect a fund of at least $100,000 from members of the profession. It is expected that the profession will show confidence in the plan by making a substantial cash contribution before larger contributions are solicited from others. Animal lovers, livestock owners and commercial organizations interested, are expected to make contributions toward a much larger sum.

The objects of the fund are twofold: (1) To advance knowledge in both the basic and the applied aspects of veterinary science. (2) To assist in the training of promising young scientists in these fields by affording them financial support, in the form of fellowships, for graduate education.

The funds obtained will be administered by the research council of the association. Applicants for fellowships supported by this fund must be citizens of the United States or Canada; they must have a veterinary degree from an institution approved by the association; they must have demonstrated ability or promise of ability in the field of their choice; and they must be accepted as graduate students by an educational institution approved for the purpose by the research council. These fellowships will not be limited to veterinary institutions. Fellows may work wherever facilities are adequate and competent supervision of their work is available.

Further details of the plan will be announced soon in the veterinary press and at veterinary meetings. In due time, all graduate veterinarians in North America will be approached individually for contributions, and it is hoped that they will respond liberally. The goal for this group may be attained, and even surpassed, by a minimum donation of $10, by each veterinarian.

So far as known, such a fund has never been sought from any professional group. It is hoped that the profession will rise to the occasion and demonstrate to others that it has pride and faith in its work and an earnest desire to improve its services through wider knowledge of animal diseases and better training for its members. The association can not expect others to support such efforts with liberality unless they are impressed with its own seriousness of purpose.

Veterinarians are asked to give careful thought to this matter and be ready to respond when called upon to do so.

BIOLOGY IN THE HIGH SCHOOL

DR. GEORGE WALD, associate professor of biology at Harvard University and member of the Harvard Committee on the Objectives of a General Education in a Free Society, sponsored an all-day conference devoted to "Biology Instruction at the High School Level," on January 17, at the New York Academy of Medicine. This session, which was organized with the active cooperation of the voluntary and official health organizations and the Board of Education of the City of New York, constituted the sixth annual Health Education Conference of the New York Academy of Medicine.

The conference considered not only the formal instruction of biology, but also the continued education of the young adult at home and in industry. In addition to Dr. Wald, participating in the conference were

Dr. Edward S. Rogers, assistant commissioner of medical administration of the New York State Department of Health; Miss Hazel Corbin, of the Maternity Center Association; Dr. Charles C. Wilson, professor of health and physical education, Teachers College, Columbia University; Dr. Frank J. O'Brien, associate superintendent of the Board of Education, and others. The chairman of the morning session was Dr. Donald B. Armstrong, second vice-president of the Metropolitan Life Insurance Company. Dr. Ernest L. Stebbins, commissioner of health of New York City, presided over the afternoon session.

The program of the conference was arranged under the following headings:

Address of Welcome; Chairman's Remarks.

Biology Instruction in General Education.

Objectives of Biology Instruction at the High School Level as seen by (a) The Educator; (b) The Biology Teacher; (c) The Voluntary Health Organization; (d) The Official Health Organization.

Panel Discussion with Audience Participating.

Summary.

Chairman's Remarks.

The Health Educator's Opportunities.

The Biology Teacher's Opportunities.

The Voluntary Health Agency's Opportunities.

Panel Discussion with Audience Participating.

Summary.

CHICAGO INTERNATIONAL SALON OF NATURE PHOTOGRAPHY

THE first Chicago International Salon of Nature Photography, for which both amateur and professional photographers have been making and entering pictures during the last several months, opened at the Chicago Natural History Museum in February.

The best of the hundreds of photographs submitted, both black and white and in colors were displayed. The judges selecting those for prizes, honorable mention and display were: B. D. Holley, of Downers Grove, Ill., an associate of the Photographic Society of America; A. H. Longwell, Chicago, professional photographer; James H. Burdett, garden editor of *The Chicago Sun*, and representative of the Chicago Horticultural Society; and Dr. Paul O. McGrew, acting chief curator of geology of the museum, and Karl P. Schmidt, chief curator of zoology.

The salon was held under the auspices of the Chicago Nature Camera Club, with the participation of the Chicago Color Camera Club, and the Chicago Horticultural Society and Garden Center. Each of these organizations awarded prizes. Associated camera clubs throughout this country and other nations were invited to participate, but entries were accepted from photographers regardless of affiliation with such clubs. While most of the pictures were out-of-doors subjects made in woods and along streams throughout the Middle West, and to some extent throughout the world, there were some of outstanding Museum material, as the camera clubs staged a field day for this purpose in the Museum in December.

The photographs and color slides were classified in six divisions:

Plant life—flowers, trees, shrubs, fungi, etc.

Animal life—mammals, birds, insects, reptiles, tracks, etc.

Scenery—with particular emphasis on geological aspects and natural phenomena.

Gardens—especially "Victory Gardens" and their products.

Anthropology—ethnological and archeological subjects; primitive man, native habitations, sites of ancient cultures and civilizations, etc.

Color slides—any subjects in the foregoing classifications.

"THE BIOLOGICAL QUARTERLY" IN CHINA

A NEW international periodical in biology called *The Biological Quarterly* is to be published in China. Although the purpose of the publication is to stimulate the interest of original research in China, it will accept articles of authors residing anywhere in the world. It will be published exclusively in English with a résumé in Chinese and will serve as a medium of scientific collaboration between biologists of the East and the West.

The Biological Quarterly will be managed and edited by three Chinese biologists: Dr. H. Zanyin Gaw, professor of biology in the National Wuhan University, Wuhan; Dr. H. L. Li, professor of botany in Soochow University, Soochow and Dr. C. C. Tan, professor of genetics in the National Chekiang University, Hangchow.

The first volume is expected to appear in 1947. Papers of original investigations and reviews of newer developments in various branches of the biological sciences will be welcomed by the editors. Their temporary addresses are: Dr. H. L. Li, Soochow University, Soochow, China; Dr. H. Zanyin Gaw, The Rockefeller Institute for Medical Research, Princeton, N. J.; Dr. C. C. Tan, Department of Zoology, Columbia University, New York 27, N. Y.

From left to right: DR. H. L. LI, Editor of the New Journal, DR. H. Z. GAW and DR. C. C. TAN

MISSION TO STUDY AGRICULTURE RELATIONS

DR. R. E. BUCHANAN, director of the Iowa Agricultural Experiment Station at Iowa State College, has leave of absence to enable him to serve as a member of a mission that left on February 10, sponsored by the Office of Foreign Agricultural Relations and the Department of State, to study agricultural relationships, particularly as they concern research and education.

Members of the mission are Dr. Afif Tannous, of the U. S. Department of Agriculture, and Dr. Franklin S. Harris, president of Utah State College.

The party has been invited by the various governments to visit the Republics of Lebanon and Syria and the Kingdoms of Iraq, Saudi Arabia and Egypt. It will work with universities, agricultural and home economics schools, and agricultural experiment and demonstration stations. The mission expects to return to the United States by June 1.

RESEARCH AT RUTGERS UNIVERSITY

RUTGERS UNIVERSITY, nine pharmaceutical manufacturers and the Army Quartermaster Corps are pooling their knowledge and resources in an extensive cooperative research program which is making basic scientific studies of the properties and therapeutic values of protein hydrolysates and amino acids.

When the work started in the fall of 1943, the Bureau of Biological Research at Rutgers was cooperating with one industrial laboratory and only the equivalent to 5.5 full-time workers and four consultants were engaged in the project. Now nine laboratories and the Quartermaster Corps are cooperating in the study and twenty-four persons, including twelve full-time investigators and seven consultants, are participating in the research effort.

Studies on the use of proteins, protein hydrolysates and amino acid mixtures in normal and hypoproteinemic dogs were started to answer basic questions for a better understanding of protein metabolism —questions which must be answered if the use of proteins and their derivatives in nutrition, therapeutics and convalescence is to have a sound basis.

It was agreed at the start of the work that all plans and results would be freely discussed at regular conferences of the bureau staff and representatives of the cooperating organizations. In addition to frequent conferences, two larger meetings were held during 1944–1945 so that other persons interested in the work could sit in on the discussions. Mimeographed reports of the proceedings were distributed to those who attended and to others who requested the information.

For the next year of the project which began on October 1, 1945, ten groups are cooperating in the project. Rutgers University through its University Research Council is contributing $32,610 and the laboratories $39,000 for the support of the work. The cooperating groups are: Sharp and Dohme Company; Swift and Company; E. R. Squibb and Sons; Arlington Chemical Company; Calco Chemical Company; Inter-Chemical Corporation; Abbott Laboratories; Merck and Company; Eli Lilly and Company; and the Quartermaster Corps of the United States Army.

A one-story, fireproof building of about 8,000 square feet of floor space is being planned to house the work and will be built when labor and material conditions permit. It will contain the most modern equipment and facilities for studies on dogs, rabbits and rats. About a third of the building will be air-conditioned.

STUDIES ON THE PHYSIOLOGY OF PAIN

DR. FRANZ R. GOETZL, of the Permanente Foundation, Oakland, California, has received a grant of $3,800 a year from the Whitehall Pharmacal Company for studies on the physiology of pain and the action of analgesic drugs. It is proposed to study the mode of action of the commonly used analgesics, as, for instance, acetylsalicylic acid and related substances. In addition, an attempt will be made to analyze the analgesic effectiveness of certain drug combinations. A thorough analysis may lead to the possibility of predicting the analgesic effectiveness of the mixtures. For measuring pain thresholds an alternating current is applied to the tooth of the subject through metal fillings, noting the least voltage necessary for producing the first painful sensation. Changes in that voltage are interpreted as changes in the pain threshold.

THE FIFTIETH ANNIVERSARY OF THE DEATH OF LOUIS PASTEUR

An account of the commemoration of the fiftieth anniversary of the death of Louis Pasteur is given in the *Journal* of the American Medical Association. It was organized by the Mexican Society of Natural History under the auspices of President Manuel Avila Camacho; Dr. Gustavo Baz, secretary of public health and welfare, Jaime Torres Bodet, secretary of public education; Marte R. Gomez, secretary of agriculture; Javier Rojo-Gómez, governor of the Federal District; Genaro Fernández-MacGregor, dean of the National University of Mexico, and Maurice Garreau Dombate, French ambassador, and was celebrated last Fall.

The unveiling of pictures and plates of Pasteur took place in the General Hospital in the National Institute of Hygiene, Popotla, D.F., and in the Faculty of Medicine. A public meeting was held before the Pasteur Memorial in Cuauhtemoc Square; the final ceremony took place in the Beaux Arts Theater, presided over by Dr. Baz. Ambassador Garreau Dombate, Dr. Manuel Martínez Baez, undersecretary of public health and welfare, and Professor Enrique Beltrán, secretary of the Mexican Society of Natural History, spoke on the life of Louis Pasteur and on the importance of scientific research from the social point of view. A large edition of "The Biography of Louis Pasteur," written by Dr. Alfonso Pruneda, life-secretary of the National Academy of Medicine, was distributed.

BUST OF PASTEUR

THE MEDICAL SCHOOL OF THE UNIVERSITY OF MICHIGAN

A change in the executive committee of the Medical School of the University of Michigan has been approved by the Board of Regents.

Under the new plan, the executive committee will consist of the dean of the Medical School; the director of the Hospital, and four additional members of the executive faculty to be appointed by the Board of Regents on recommendation by the president of the University.

The appointed members will consist of a representative from each of two clinical departments and a representative from each of two pre-clinical departments. Previously there had been no provisions for apportioning membership among the departments.

The new plan had received approval of the executive committee and the executive faculty of the School of Medicine before final approval was given by the Board of Regents.

FELLOWSHIPS IN MEDICAL RESEARCH

ACTING as agent for various national societies, the National Research Council is offering additional fellowships which are available to newly separated officers of the Department of Medicine holding M.D. or Ph.D. degrees. These fellowships are in the fields of cancer research and anesthesiology.

Funds for the former are being provided by the American Cancer Society and are administered by the newly appointed Committee on Growth of the National Research Council. Fellowship stipends vary from $2,000 to $3,000 per year. They are intended, as a rule, for those who are under thirty-four years of age. Although they are for a period of one year, they may be renewed. A limited number of senior fellowships for older, particularly well-qualified individuals planning to specialize in cancer research are available for three-year periods with stipends of $3,000 to $6,000 per annum. Applications should have been filed before February 1.

Fellowships in anesthesiology, supported by the American Society of Anesthesiologists, are in addition to those in filtrable viruses, orthopedic surgery and the medical sciences. Applications should be filed before July 1. Further information and application forms can be obtained from The Chairman, Division of Medical Sciences, National Research Council, 2101 Constitution Avenue, Washington 25, D. C.

VITAMIN D PATENTS GIVEN TO THE PUBLIC

THE Vitamin D patents owned by the Wisconsin Alumni Research Foundation have been dedicated to the public. The Government filed suit in October, 1944, charging the foundation and seventeen "of its so-called licensees" with unlawfully conspiring to restrain and monopolize trade and commerce in vitamin D and vitamin D products, enjoining the foundation from instituting suits for infringement or collecting royalties based upon any of the patents dedicated to the public and also enjoining the foundation from entering into any future licensing of patents relating to vitamin D which provide for price-fixing or impose restrictions upon the manufacture, use or sale of vitamin D or vitamin D products.

Simultaneouesly, the foundation announced that it has dedicated to the public all patents relating to the production of vitamin D and that all litigation pending on these patents has been ended.

Dr. George F. Haight, president of the foundation, made a statement in which he said that "the foundation not only did not oppose Government intervention in its patent infringement suit, but aided it in becoming a party."

THE SOUTHWESTERN MEDICAL FOUNDATION

THE Southwestern Medical Foundation has established a separate Department of Experimental Medicine in its Medical School at Dallas, Texas, under the directorship of Dr. Arthur Grollman.

In establishing this department the trustees have taken cognizance of the increasing importance of research in relation to clinical medicine. It will serve to integrate the work in clinical medicine with the basic sciences of the pre-clinical departments.

Teaching emphasis will be placed on the application of physiological, biochemical and pharmacological principles to the practical problems of the clinic. Research will continue on problems relating to the broad fields of experimental medicine both in the laboratory and in the hospital.

FORESTRY AT MICHIGAN COLLEGE

DR. HEREFORD GARLAND

THE Michigan College of Mining and Technology has appointed Dr. Hereford Garland, a member of the staff, to direct its projects under the research program of the collaborative forest-industries, for which $25,000 has been appropriated by the State of Michigan. The Michigan Planning Commission has announced the allocation of research projects, acting on recommendation of the Forest Products Research Committee, of which Dr. Grover D. Dillman is chairman. The University of Michigan and Michigan State College are also engaging in research under the same program.

The college will make an inventory of wood-using industries of the Upper Peninsula and study the present and potential utilization of aspen. The wood industries inventory will give a factual basis for intensive work on developmental problems of wood production and use. A contact survey will be made of all types of primary and secondary wood-using plants in the region. Particular emphasis will be placed upon the possible uses of waste wood and on more complete manufacture of wood products in the Upper Peninsula.

Aspen or "popple" is the principal species on about five million forest acres in Michigan. A study will be made of the properties of the wood, its suitability for different uses and the most efficient methods of converting it into useful products.

Dr. Garland came to Michigan College from the California Forest and Range Experiment Station, U. S. Forest Service, at Berkeley, Calif., where he was forest products technologist acting in charge of the Division of Forest Products.

DR. LINK AT THE BROOKLYN BOTANIC GARDEN

DR. CONRAD B. LINK, assistant professor of horticulture at Pennsylvania State College, has been appointed horticulturist at the Brooklyn Botanic Garden.

He obtained three degrees at Ohio State University: B.S., 1933, M.S., 1934, and PhD., 1940. He has been hybridist (1934–1935) at Good and Reese, Inc., Springfield, Ohio; assistant in horticulture, the Ohio State University from 1935 to 1938; extension specialist at the Ohio State University, with commercial florists from 1939 to 1940. He was instructor at Pennsylvania State College, 1938–1941, and assistant professor from 1941 to 1945. At Pennsylvania State, in addition to his teaching, he carried out research work in soils and fertilizers, greenhouse roses and annuals and perennials. At the Brooklyn Botanic Garden he is in charge of the grounds and conservatories, and will be associated with others in the development of horticultural research.

DR. THIMANN RETURNS TO HARVARD

Bachrach

DR. KENNETH V. THIMANN

DR. KENNETH V. THIMANN, associate professor of plant physiology at Harvard University, writes that he has returned to Harvard after being on leave of absence since October, 1942. He was with the Operations Research Group (Navy) working in the Commander in Chief's Office in Washington, and also in London and at Pearl Harbor. Before going on leave he directed and completed an OSRD research contract in the Biological Laboratories at Harvard.

Dr. Thimann plans to take up again some problems concerned with the action of hormones in plants, particularly the binding of reserve auxin to other constituents of the cell, and the nature of the primary reaction which auxin brings about and which leads to growth. It is hoped also to be able to bring to completion some studies in this field which were under way in 1941 and were interrupted by the war. These experiments are envisaged as part of the approach to a more fundamental knowledge of the nature of growth. A good deal of the value of our present extensive knowledge of the auxins and other plant hormones lies in the possibility which this offers to investigate more closely the growth process itself. Both these problems have been well started, the former by studies of the extraction and hydrolysis of bound auxin in plant tissues, the latter by work on the relation between auxin, protoplasmic streaming and respiration. He also expects to find time to initiate a study, which has long been projected, of the physiology of the formation of anthocyans in leaves. His regular teaching program comprises courses in the physiology of the higher and lower plants.

Throughout the war Dr. Thimann retained the editorship, jointly with Professor Robert Harris, of the Massachusetts Institute of Technology, of the annual review, "Vitamins and Hormones," and this will be continued.

DR. ORVILLE WYSS AT THE UNIVERSITY OF TEXAS

DR. ORVILLE WYSS, who was recently appointed associate professor of bacteriology at the University of Texas, has assumed direction of courses and graduate research in bacterial metabolism. A new course is being presented for advanced students which emphasizes the biochemical techniques employed for the study of the physiology of bacteria. Dr. Wyss will also collaborate with the staff in preparing a textbook on general bacteriology.

Dr. Wyss is still working on several phases of the problem of competitive inhibition and the use of inhibitions, a technique which he first encountered in his work for the doctorate thesis at the University of

Wisconsin. He is also continuing studies on bacterial inhibition and death which he initiated while chief microbiologist for the Wallace and Tiernan Company, Belleville, N. J. These include the synergistic action of useful combinations of antimicrobial agents, the action of halogens and of surface-active agents.

The University of Texas has received a grant from the Subsistence and Development Laboratory of the Quartermaster Corps to set up a project under the direction of Dr. Wyss to study the mode of action of antibacterial agents with special reference to those substances which might be useful to the food industry.

DR. ERNEST W. LINDSTROM OF IOWA STATE COLLEGE

Dr. Ernest W. Lindstrom, professor and head of genetics at the Iowa State College at Ames and Vice-Dean of the Graduate College, has returned to take up his work at the college after spending a year in Colombia, South America, as exchange professor at the Facultad Nacional de Agronomia in Medellin, where he taught genetics, plant breeding and statistics, and also developed a comprehensive hybrid corn program.

Dr. Lindstrom was born in Chicago in 1891 of Swedish parents. He graduated from Lake View High School in 1909 and attended Colorado College for three years (1910–1913) where he majored in biology. His final undergraduate year was taken at the University of Wisconsin, where he received the A.B. degree in 1914 with a major in botany.

His graduate work began in 1914 at the University of Nebraska, where he was assistant to Dr. R. A. Emerson. When the latter moved to Cornell University as head of the Department of Plant Breeding, Dr. Lindstrom followed him to Ithaca in the fall of 1914. Three years of graduate study at Cornell in this department, where he was graduate assistant in the maize research program, were completed in 1917 when he received the degree of Ph.D. with a thesis entitled "Chlorophyll Inheritance in Maize."

Dr. Lindstrom entered the Air Service in the summer of 1917 as a flying cadet, was commissioned as Second Lieutenant in the Army Air Service in 1918 and served in France as a bombing pilot with the 96th Day Bombardment Squadron.

When he returned from France, he became instructor in the Department of Genetics at the University of Wisconsin where he later became assistant professor. In 1922 he resigned to establish a new department of genetics at the Iowa State College. There he has developed a center of theoretical and applied genetics with major research projects in the genetics of maize,

DR. ERNEST W. LINDSTROM

hybrid corn, polyploidy in tomatoes and bacterial-disease resistance in maize. Since 1922 he has served as head of the department, and since 1937 as vice-dean of the Graduate College.

During 1927–28 he served a year in the Paris office of the International Education Board of the Rockefeller Foundation, assisting with fellowship programs in biology and agriculture.

Dr. Lindstrom holds membership in the Genetics Society of America, having served as general secretary from 1938–1940, and as national president in 1942. He is also a member of the American Society of Naturalists of which he was secretary for three years (1932–1934). He is a member of Beta Theta Pi and also of the graduate fraternity Gamma Alpha.

The general genetics organization at Iowa State College comprises the staff of the Department of Genetics (E. W. Lindstrom, J. W. Gowen and three technicians) and the integrated programs in Animal Husbandry (J. L. Lush, A. W. Nordskog), in Agronomy (I. J. Johnson, M. G. Weiss, C. P. Wilsie) and in the U. S. Department of Agriculture with resident collaborators (W. A. Craft, G. F. Dickerson and G. F. Sprague).

APPOINTMENTS IN THE DIVISION OF BIOLOGICAL SCIENCES AT THE UNIVERSITY OF CHICAGO

Dr. Leon O. Jacobson has been appointed assistant professor of medicine and associate dean of the Division of the Biological Sciences (which includes the School of Medicine) of the University of Chicago. The other administrative officers of the division are: Dr. R. Wendell Harrison, dean; Dr. A. C. Bachmeyer, associate dean and director of clinics; Dr. Thomas Park, associate dean, and Dr. F. J. Mullin, assistant dean of students.

In 1942 Dr. Jacobson became associated on a part-time basis with the University of Chicago group working on the possibilities of atomic explosives. Later he went on leave of absence to devote his full time to the activities of the Metallurgical Laboratory as associate director under Dr. R. S. Stone, director of health. The Health Division conducted biological investigations on the effects and mechanism of action of uranium, external radiations and radioactive fission products; it had responsibility for the protection of the laboratory scientists and associated personnel from the radiation hazards encountered in the research and development of uranium piles and plutonium production.

DR. GILLAM JOINS THE MIDWEST RESEARCH INSTITUTE

Dr. W. S. Gillam, professor of agricultural chemistry at Purdue University, has joined the staff of the Midwest Research Institute at Kansas City. Dr. Gillam is in charge of the analytical work and will carry on research in soils and plant nutrition. In addition, he will work on a project sponsored by the United States Army Engineers Corps calling for a survey of the major agricultural resources of the Missouri River Basin, which includes a study of soils, crops, natural vegetation, climate, growing season, etc. He will make recommendations for land utilization of the area. Dr. Gillam received his bachelor degree in chemistry at DePauw University and his master's and doctor's degrees at the University of Nebraska. Before joining the staff at Purdue University he was successively a member of the faculties of the Michigan State College, Nebraska Wesleyan University and the University of Nebraska.

SHORT NOTES

Dr. E. S. Goodrich, F.R.S., Linacre professor of zoology and comparative anatomy in the University of Oxford, died on January 6 in his seventy-eighth year.

Dr. Charles T. Burnett, professor emeritus of psychology of Bowdoin College, died on January 31 at the age of seventy-two years.

Dr. Chester Arthur Stewart, director of the department of pediatrics at Louisiana State University, died on February 8 at the age of fifty-five years.

Dr. Albert Perkins Tibbets, a former president of the Washington, D. C., Medical and Surgical Society, died on January 31 at the age of 61 years. A graduate of Dartmouth College and the George Washington University School of Medicine, Dr. Tibbets was a member of the Military Order of the World War, a fellow of the American College of Surgeons and a staff member of the Washington Episcopal Eye, Ear and Throat Hospital.

The Richard Pearson Strong Medal has been conferred on Brigadier General George R. Callender for his wartime achievements as director of the Army Medical School. The medal was presented at the annual meeting of the American Foundation for Tropical Medicine. The citation reads in part that researches carried out by the school "contributed directly to the achievement of the lowest sick rate of any army in the history of war." An African Research Institute will be established within the foundation for the study of tropical diseases in Africa. Grants amounting to $38,000 for research in tropical medicine were distributed in 1945 by the foundation, which is supported by leading chemical companies and by corporations that operate in the tropics.

Dr. John H. Stokes, director of the Institute for the Control of Syphilis of the University of Pennsylvania, was presented at the annual meeting of the American Social Hygiene Association in New York with the William Freeman Snow Medal, given annually for distinguished service to humanity. The presentation coincided with the trans-ocean broadcast of the bestowal in London of a similar award on Sir Lawrence W. Harrison, of the British Ministry of Health.

Awards amounting to £10,000 were made on February 23 in London to the three scientists who discovered and developed penicillin. A check for £5,000 was presented to Sir Alexander Fleming, and checks for £2,500 each were handed to Sir Howard Florey and Dr. Boris Chain, his co-workers. The gifts were from a £25,000 trust fund created in 1924 by Sir Harold Harmsworth and his father, the late Sir Leicester Harmsworth, to encourage research into the causation and treatment of infective endocarditis, a disease from which one of Sir Leicester Harmsworth's sons and his brother, Lord Northcliffe, died.

Lieutenant-Colonel David B. Dill, director of the fatigue laboratory of Harvard University, has been awarded the Legion of Merit for "significant contribution to the scientific progress of the United States Army." The presentation was made on January 30 by President James B. Conant.

Colonel Wallace H. Graham, personal physician of President Truman, recently appointed professorial lecturer in surgery at the George Washington University School of Medicine, took up his work on February 3. Colonel Graham has been in the U. S. Army since 1941, serving as chief of surgery of the 24th Evacuation Hospital in the European theater. Before that time he was a member of the surgical staffs of St. Joseph's Hospital, the Research Hospital and the Kansas City General Hospital.

Dr. Kenneth E. Caster, on leave of absence as assistant professor of geology and

fellow of the Graduate School of Arts and Sciences of the University of Cincinnati, has been named an original fellow to organize the Brazilian Geologic Society. At the request of the U. S. Department of State and the University of São Paulo, Brazil, he will remain for a second year at the latter university, where he is director of and visiting professor in the department of geology and paleontology.

Lieutenant Wayne Dennis, USNR, professor and head of the department of psychology at Louisiana State University, has been named head of the department of psychology of the University of Pittsburgh.

Dr. Alfred Blalock, professor of surgery, School of Medicine of the Johns Hopkins University and surgeon in chief of the Johns Hopkins Hospital, is reported to have declined an invitation from Columbia University and the Presbyterian Hospital, New York City, accept to similar positions there.

Dr. Max E. Britton, assistant professor of botany at Northwestern University, resumed teaching on February 1 after an absence of over two years in the armed services. He spent most of the time in the Southwest Pacific attached to hospital units. At Northwestern University he will have charge of plant ecology.

Dr. Curtiss B. Hickcox has been named head of the department of anesthesiology and Dr. Dean A. Collins, of the Mayo Clinic, Rochester, Minn., has been appointed professor of physiology in the medical school and hospital of Temple University, Philadelphia.

Dr. Donald S. Farner has been appointed assistant curator in ornithology in the Dyche Museum of Natural History of the University of Kansas and assistant professor in the department of zoology. He served for three years in the armed forces before taking up his new positions in January.

Dr. Marshall T. Newman recently returned to his position as associate curator of physical anthropology, U. S. National Museum, after three years active duty in the Naval Reserve.

Dr. Hugh Richard Gault, of the Alaskan Branch of the United States Geological Survey, has been appointed assistant professor of geology at Lehigh University.

A gift from Harvey N. Ott, of Buffalo, N. Y., supplemented by college funds, has made possible the purchase by Albion College of a tract of land, comprising over 300 acres three miles east of Battle Creek, to serve as its Biological Preserve.

Colonel Stafford L. Warren, professor of radiology at the University of Rochester, delivered the fifth Harvey Lecture of the current series at the New York Academy of Medicine on February 21. He spoke on "The Story of Nagasaki."

Dr. Armand J. Quick, professor of biochemistry at the School of Medicine of Marquette University at Milwaukee, delivered the twenty-second Lewis Linn McArthur Lecture at the Palmer House, Chicago, on February 22. His subject was "The Coagulation of the Blood: Theoretical and Practical Aspects."

Dr. E. C. Stakman, chief of the Division of Plant Pathology and Botany of the University of Minnesota, delivered on February 6 before the Sigma Xi Chapter of North Carolina State College, a lecture entitled "Plant Diseases are Shifty Enemies."

Rehabilitation of medical libraries in the liberated countries of Europe will be undertaken by the British Royal Medical Society, which will establish a Central Library Bureau with a grant of £61,725 from the Rockefeller Foundation of New York. The fund is to cover maintenance for four years. It is planned to help libraries that have been damaged by bombs and by deprivation. Later a permanent service will be developed for the rapid exchange of ideas between institutions and individuals.

It is reported in *The Times*, London, that accompanying a gift of $5,000 from the Mayo Foundation to the Royal College of

Surgeons is a letter from Dr. Donald C. Balfour, Director of the Mayo Foundation of the University of Minnesota, to Sir Alfred Webb-Johnson, President of the College, expressing the desire of the staff of the Mayo Clinic to help in the restoration of the college buildings and facilities so that the great influence of the college in elevating surgery and the surgical specialties will be continued in the British Empire and throughout the world.

President H. W. Dodds, of Princeton University, has announced the commencement of work on the Harvey S. Firestone Memorial Library. It is expected that the library will be ready for use by the fall of 1947, and that the total cost will amount to $4,000,000; there will be storage space for two million books, twice the number in the present collection of the university. President Dodds called attention to the increased importance of the library in view of the new study plan at Princeton, which provides for greater independent research by upperclassmen.

Dr. Co Tui, director of the Laboratory of Experimental Surgery of the School of Medicine of New York University and vice president of the American Bureau for Medical Aid to China, who pioneered in experiments in feeding predigested proteins to persons suffering from malnutrition, peptic ulcers and wounds or shock, has left for Shanghai. He plans to undertake scientific missions at the invitation of China's Minister of War. It is planned to set up plants in China for the manufacture of non-pyrogenic intravenous fluids and to introduce the use of protein hydrolysates (pre-digested proteins). These can be assimilated by persons who can not digest ordinary foods.

Northwestern University has received a gift of $120,000 from the Colgate-Palmolive-Peet Company for dental research. A study of oral hygiene in relation to tooth decay will be directed by Dr. Leonard S. Fosdick, professor of chemistry in the dental school.

The British Agricultural Research Council, in conjunction with two agricultural councils, is preparing a comprehensive plan for agricultural research, with full application of genetical science to animal breeding and vegetable growing.

Charles Sumner Woolworth, of Scranton, Pa., a founder of the Woolworth chain stores, has made a gift of $100,000 to Syracuse University, of which he is a director of the Board of Trustees, to be used without restriction for the best interest of the university.

The Rockefeller Foundation has made a special grant of $78,500 to the National Health Council to support a program of coordination of the voluntary health agencies of the country. It will cover operations of the group for 1946 and will be used to strengthen and unify the work of the 20,000 privately supported health societies whose activities have been the subject of a four-year Council study. Under the grant the Council plans to establish facilities for joint planning, joint activities and joint services for the national agencies; the organization of new health councils and the strengthening of established ones throughout the country, and an active field service to give practical counsel to local agencies on organizations' problems.

The University of Berlin was formally reopened on January 29, in a ceremony in which Allied occupation officials mingled with academically robed teachers. Since most of the university buildings were destroyed during the war, classes will be resumed in various buildings throughout the city.

SCIENCE IN CONGRESS

THE second session of the 79th Congress commenced on January 14, 1946, and a review of the *Congressional Records* following that date yields many items of interest to scientists in the proceedings and debates:

BILLS AND RESOLUTIONS INTRODUCED

H. R. 5144. A bill to establish a national air museum, and for other purposes. Introduced by Congressman Randolph, January 15.

H. R. 5193. A bill to prescribe minimum qualifications for pharmacists employed by the United States. Introduced by Congressman Lemke, January 21.

H. J. Res. 305. Joint resolution providing for membership and participation by the United States in the United Nations Educational, Scientific and Cultural Organization, and authorizing an appropriation therefor. Introduced by Congressman Merrow, January 28.

H. R. 5299. A bill to provide for a preliminary examination and survey of the Pecatonica River with a view to the controlling of floods. Introduced by Congressman Stevenson, January 30.

H. R. 5319. A bill to authorize a preliminary examination and survey of Pecatonica River, Wisconsin and Illinois, for flood control, for run-off and water-flow retardation, and for soil-erosion prevention. Introduced by Congressman Smith of Wisconsin, January 31.

H. R. 5332. A bill to create a Department of Science and Research. Introduced by Congresswoman Luce, February 1.

H. Con. Res. 124. Concurrent resolution providing for the discontinuance of the manufacture of atomic bombs until further action by the Congress. Introduced by Congressman Burgin, January 30.

H. R. 5364. A bill for the development and control of atomic energy. Introduced by Congresswoman Douglas of California, February 4.

H. R. 5365. A bill for the development and control of atomic energy. Introduced by Congressman Holifield, February 4.

S. 1824. A bill to provide temporarily for the development and control of atomic energy. Introduced by Senator Johnson of Colorado, February 9.

H. R. 5380. A bill to provide for the conferring of the degree of bachelor of science upon graduates of the United States Merchant Marine Academy. Introduced by Congressman Keogh, February 5.

H. R. 5401. A bill to provide for the protection of the Dall sheep, caribou and other wildlife native to the Mount Mckinley National Park area, and for other purposes. Introduced by Congressman Angell, February 6.

DISCUSSION, DEBATE, EXTENDED REMARKS

Extension of remarks of Congressman Murdock on "There Is a Call for Clarification of the 1939 Reclamation Law," *Congr. Rec.*, January 14, 1946, p. A27.

Extension of remarks of Congressman Murray of Wisconsin on "Trees for Tomorrow, Inc.," *Congr. Rec.*, January 15, 1946, p. A50; and on "Five Million Trees Planted by Farmers and Youths," *Congr. Rec.*, January 15, 1946, p. A52. Quotes editorials from Antigo, Wis., *Daily Journal* and Manawa, Wis., *Advocate*.

Address by Senator Morse on the Twenty-fifth Radio Anniversary, *Congr. Rec.*, January 17, 1946, p. A79.

Extension of remarks by Senator Smith on "Science Research Foundation," *Congr. Rec.*, January 17, 1946, pp. A80–A81. Quotes editorial from Newark *Evening News*.

Extension of remarks of Senator Briggs on "Judaism and Race Relations," *Congr. Rec.*, January 17, 1946, pp. A86–A87. Includes statement of Rabbi Ferdinand M. Isserman, of St. Louis, on science and race, colored races in the Pacific, etc.

Extension of remarks of Congressman Bryson on "Mathew Fontaine Maury, Pioneer in the Science of Navigation," *Congr. Rec.*, January 21, 1946, p. A134.

Extension of remarks of Congressman Gifford, quoting article on "Some Reflections on the Progress of Science and the Magnuson-Kilgore Bill," by Dr. Theodore Koppanyi, Georgetown University, *Congr. Rec.*, January 21, 1946, pp. A139–142.

Debate on Independent Offices Appropriation Bill, 1947 (including appropriations for the Smithsonian Institution), *Congr. Rec.*, January 23, 1946, pp. 277–313.

Extension of remarks of Congressman Randolph on "Model Aeronautics and the War Effort," *Congr. Rec.*, January 23, 1946, pp. A191–A192.

Extension of remarks of Congressman Coffee on "Secrecy and the Atomic Bomb," *Congr. Rec.*, January 23, pp. 193–A194. Quotes editorial from Salem, Oregon, *Capital Press.*

Debate on United Nations Educational, Scientific and Cultural Organization, including text of the Constitution of the Organization—London Conference Document No. 26, *Congr. Rec.*, January 28, 1946, pp. 459–466.

Speech of Congressman Merrow on "United Nations Educational, Scientific and Cultural Organization," *Congr. Rec.*, January 28, 1946, pp. A269–A270.

Debate on the proposed National Science Foundation, *Congr. Rec.*, January 30, 1946, pp. 575–576.

Extension of remarks of Senator Butler on "Reclamation," *Congr. Rec.*, January 30, 1946, pp. A357–A359.

Extension of remarks of Congressman Coffee on "More on Atomic Energy," *Congr. Rec.*, January 30, 1946, pp. A374–A375. Quotes editorial from *St. Louis Post-Dispatch.*

Extension of remarks of Senator Thomas of Utah on "Atomic Bombs in International Society," *Congr. Rec.*, January 30, 1946, pp. A385–A387. Quotes the Senator's article from the *American Journal of International Law.*

Discussion of the Naval Atomic Bomb Experiment, *Congr. Rec.*, January 31, 1946, p. 641.

Extension of remarks of Senator Myers on "The Schuylkill River Restoration Program," *Congr. Rec.*, January 31, 1946, pp. A398–A399.

Extension of remarks of Senator Briggs on "Missouri Valley Authority," *Congr. Rec.*, February 1, 1946, pp. A435–A440. Includes supplemental statement by F. V. Heinkel.

Extension of remarks of Senator Butler, quoting statement by Harry W. Bashore before the Nebraska Reclamation Association, *Congr. Rec.*, February 1, 1946, pp. A442–A444.

Extension of remarks of Congresswoman Luce on "Department of Science and Research, *Congr. Rec.*, February 1, 1946, p. A452. Gives text of H. R. 5332.

Extension of remarks of Congressman O'Konski on "Needs for an Experimental Forest in Northern Wisconsin," *Congr. Rec.*, February 4, 1946, pp. A482–A483.

Extension of remarks of Congressman Brooks on "A Great and Rich Valley [Red River]," *Congr. Rec.*, February 4, 1946, pp. A499–A500. Quotes statement by W. Harry Johnson.

Extension of remarks of Senator Bushfield on "The American Indian and Government," *Congr. Rec.*, February 5, 1946, pp. A513–A515. Quotes article by Byron Brophy.

Extension of remarks of Congressman Judd on "Scientific Training," *Congr. Rec.*, February 6, 1946, pp. A559–A560. Quotes article by Howard A. Meyerhoff, executive secretary, AAAS, from *Science.*

Extension of remarks of Congressman White quoting speech by Charles A. Lindbergh on "Aviation in the Atomic Era." *Congr. Rec.*, February 7, 1946, pp. A578–A579.

BOOK REVIEWS[1]

Edited by PROFESSOR CARL L. HUBBS

Heredity and Its Variability. By T. D. LYSENKO. Translated from the Russian by Theodosius Dobzhansky. New York: King's Crown Press, 1946: i–vi, 1–65. $0.50.

FOR many years now genetics has been a respected branch of science. Forgotten are the days when Bateson and the biometricians fought their battles and forgotten too are the arrowheads which the opponents of the chromosome theory of inheritance shot against the armor of the cytogeneticists.

But, in recent years, we have heard, the foundations of genetics have come again under scrutiny and have been found wanting by Professor T. S. Lysenko, member of the Academy of Sciences of the U.S.S.R. The controversy betwen Lysenko and the geneticists of his country has been poorly understood outside of Russia mainly due to lack of knowledge of the arguments used by Lysenko. The English translation of the present booklet, by Professor Dobzhansky, will enable biologists unfamiliar with the original Russian to form their own conclusions.

Lysenko's book was first published in 1943 and reprinted in 1944. Its purpose is to justify his own point of view, often referred to as "Michurinist" after a Russian pomologist, and to show the errors of what are called the "Mendelian-Morganian geneticists."

Lysenko's procedure consists in stating a definition of heredity, deducing consequences from the definition, attempting to demonstrate the correctness of deduced consequences and, if unexpected phenomena are encountered, making additional theoretical assumptions to explain them.

He defines as identical "the nature of the living body" and "the heredity of the living body." Since different external conditions can cause differences in the appearance of a developing organism, he speaks of changes in its nature, *i.e.*, in its heredity. Since, furthermore, different parts and different cells have different properties they are said to have different heredities. Sex cells are called "the products of the development of the entire organism." They are thought of as being physically built up from hereditary elements of every part of the whole plant or animal (apparently in accordance with Darwin's long abandoned hypothesis of pangenes). If the "heredity" of the organism changes easily under outside influences and if the germ-cells are composed of the metabolic derivatives of such changed "heredity," it follows that the offspring may itself possess a changed heredity. Lysenko is aware of the non-transmission of many individually changed traits. These he regards as changes within the norm. "But the deviations from the norm . . . are the source of alterations of the breed." Lysenko is certain that by changing in a desirable way the physiology of one generation he can always direct the heredity of the breed into new channels "without waiting for accidents." But of the geneticists he says, "In their opinion the causes of mutations are still undiscovered."

Proof for Lysenko's basically Lamarckian views is offered in three groups of phenomena mainly, those of "vegetative hybrids," of permanent hereditary changes allegedly induced by special treatments, and of other changes supposedly induced by crossing. Lysenko describes grafting experiments between tomatoes with white and with red-colored fruits. It is stated not only that "in some cases the fruits of the scion (of albino origin) will be colored in various degrees," but also that the majority of seeds from the scion in the

[1] Except as otherwise indicated, all items are prepared by the Review Editor, Dr. Carl L. Hubbs, Scripps Institution of Oceanography, University of California, La Jolla, California. All opinions are those of the reviewer.

next generation gave red-fruited progeny, whereas in a minority of plants the fruits were white or slightly reddish. "Similar results can be observed with any character." Therefore, "vegetative hybrids do not differ in principle from those obtained sexually. Any character can be transmitted from one breed to another through grafting as well as sexually." This is as expected if the scion can "assimilate . . . nutrient materials prepared by the variety the properties of which are to be transmitted to the scion." Lysenko charges the Mendelian-Morganian geneticists with ignoring these facts, "from time to time calling them experimental errors. But they do not undertake to repeat these investigations because they are afraid to obtain vegetativbe hybrids." Lysenko does mention that geneticists have analyzed such cases of graft hybrids in terms of mixtures of separate tissues of stock and scion, but he maintains "that which they cannot deny, they place in the category of unintelligible, inexplicable phenomena called chimeras." He thus seems unaware of the great variety of well-understood processes which genetics has shown to be responsible for the appearance of chimeras.

Lysenko's proofs of permanently changed heredity as a result of special treatment concerns mainly his work on vernalization. By means of suitable temperature treatment he states that it is not only possible to make winter wheat grow successfully after spring sowing, and to change plants from spring varieties into winter hardy ones but also that a permanent transformation of varieties results in this way. No quantitative data are offered in the present publication, but the general description of the large-scale sowings in successive generations which result in gradual intensification of the new property, impress the reviewer as that of a typical selection experiment with genetically nonuniform material.

"Assimilation" of the nonliving environment or of the living environment of a scion, is not the only cause of changed "heredity." If two diverse forms are crossed, one may completely assimilate the other. Let emasculated wheat plants be "given the opportunity of being fertilized by any kind of pollen. The amount of foreign pollen available was very much greater than that of the same variety." When the offspring are reared "all these plants, except for a small percentage, did not differ morphologically from the maternal type." To Lysenko these plants are hybrids, nevertheless. They show that "the maternal heredity has consumed, assimilated the paternal one"! Or consider crossing the 16-chromosome plum "Ceresota," as mother, with the 48-chromosome plum "Renelod Reforma" as father. "The plant obtained from the cross had the habit of the paternal form, including the 48 chromosomes." To Lysenko obviously here the paternal heredity has consumed the maternal. These examples do "not fit at all the cytogenetic mould invented by the Morganians." The reviewer, for one, will think of this interesting case as a new example supporting the chromosome theory.

The geneticists of this century are not the only ones chided. The 3:1 "pea law" is "basically wrong even for pea hybrids, including the actual material obtained by Mendel himself." Why? "The progenies of different plants varied even in Mendel's experiment much beyond the ratio 3:1." As proof two of Mendel's cases are quoted, one plant with 19 yellow and 20 green seeds, and another with a single green for 30 yellow ones. That such variations are within expectation when, as in Mendel's studies, more than 250 samples are collected, is well known, and in addition R. A. Fisher has specifically commented in this sense on these two cases. Moreover, both cases are quoted wrongly. In Mendel's paper we read: 20 yellow and 19 green, and a single green for 32 yellow ones. Small mistakes admittedly, but they do not infuse confidence in the reliability of less easily verified assertions.

Genetics is a vigorous science. It changes and will continue to change its con-

cepts to incorporate new facts and ideas. The newer structures of genetics will include the older ones, some unchanged as parts of a greater edifice, others altered. Lysenko may or may not have discovered new facts. In any case his attempt to ignore nearly a half-century of scientific achievements seems to have resulted in replacing rational insights by hunches and vague generalities. Both theory and practice can only be losers in such wasteful neglect.—CURT STERN, *University of Rochester, Rochester, N. Y.*

The Fresh-water Fishes of Siam, or Thailand. By HUGH M. SMITH. Bull. U. S. Nat. Mus., 188, 1945: i–xi, 1–622, figs. 1–107.—Posthumously published, this long-awaited monograph presents what is known of "a fresh-water fish fauna of great variety and abundance," comprising 49 families and more than 500 species. The richness of the fauna is attributed to the peculiarly favorable and greatly varied physical and biological conditions. To these factors one should add the great age of the continental mass of which the Malay Peninsula and the formerly connected East Indian area are a part. The close similarity between the fresh-water faunas of Thailand and of Sumatra, Java and Borneo is attributed, in harmony with the conclusions of Dutch geologists, to the former confluence of the stream systems of the mainland and of the islands. In referring to the likeness between the Thailandian and the Indian fluviatile faunas, Dr. Smith quotes Sunder Lal Hora's explanation that is based on the beheading of eastern by western rivers, indicating a westward dispersal.

Many systematic and diverse ecological elements are shown to constitute the speciose fish fauna of the streams, lakes and swamps of Thailand. The Cyprinidae alone are represented by 206 species, referred to 55 genera and occupying almost all niches. The related Cobitidae contribute 38 additional kinds. The catfish group (Nematognathi) is represented by 100 species. Many other kinds belong to essentially marine groups.

Adaptations that enable fishes to live in the varied habitats are briefly discussed in the introduction. Some emphasis is given to the various devices that have been evolved for the utilization of atmospheric oxygen by fishes living in stagnant tropical waters, but there is no reference to the enlightening researches by Carter and Beadle. Bare mention is accorded either the habit of aestivation or the modifications that have made fish life possible in mountain torrents. A new idea is the protection of the delicate interradial membranes of rapid-water fishes by flanges from the fin rays.

Interesting notes on ecology, habits and economics are scattered through the systematic text. Outstanding are remarks on the feeding habits of the archerfish (which captures its prey by spitting water drops), on the terrestrial wanderings of several species, and on the fighting habits, of *Betta* and other fishes, that play a leading role in the life of the natives.

Carefully prepared keys render the monograph serviceable as a manual, though the species accounts are largely confined to critical notes on distribution, characters and nomenclature. The fishes are copiously illustrated, but the geographical and ecological discussions suffer from the lack of maps and habitat pictures.

A Naturalist in Cuba. By THOMAS BARBOUR. An Atlantic Monthly Press Book. Boston: Little, Brown and Company, 1945: i–x, 1–317, 16 pls. $3.00.

"THE last of the real naturalists" is the tribute that we biologists, in this age of specialization and technicality, are apt to accord the memory of one who, until his recent death, has maintained and emanated an embracing interest in all life throughout the world. But is the tribe really dying? Can all inquiring minds become restricted to one region or become confined to a limited field of interest? Can all of us deny ourselves the satisfaction that

comes from a broad understanding of nature? Can we as a group afford to lose the integrating potentialities of the broad view, even though few are privileged to hold this view? Should nonprofessionals with a healthy interest in natural history be denied the lessons and the examples that real naturalists alone can provide? No, the tribe can not, must not die.

So long as great naturalists write such books as *Naturalist at Large*, *That Vanishing Eden*, and now *A Naturalist in Cuba*, activity and interest in general natural history will not cease.

A sympathetic reader can not fail to long for the richness of experience and the breadth of view that came to Thomas Barbour through his field researches, travel and rest in Cuba. Throughout his last book, a heart filled with generosity and understanding is indicated by the admiration that is repeatedly expressed for the naturalists of Cuba—Felipe Poey, Johannes Gundlach, Carlos de la Torre and their followers and students. Personal satisfaction, tempered with modesty, is cryptically revealed by the almost hidden indications of the prominent part that the author himself played in the growth of Cuban biology —by developing "The Garden of Soledad," by sending young American biologists to Cuba, and by arranging for and encouraging study and research in the United States by young Cuban naturalists. Human understanding and joy of living well are reflected in the friendly and tolerant attitude toward Cubans and their ways. Evidence of hearty enthusiasm is all-pervading.

A wealth of natural history information is scattered through the book, often with reflections of general import. Thus in the account of the reptiles and amphibians of Cuba there is a treatment of the phenomenon of phragmosis—the habit of blocking an enemy's entrance into a retreat by means of a hard shieldlike part of the protected animal's own body. In a narrative of biological exploration in the caves of Cuba consideration is given to the characteristics of cave animals. References to mollusks centers about extensive speciation on the isolated limestone *mogotes*. Problems of origin, dispersal, extinction and conservation are emphasized in the discussions of the birds and mammals of Cuba, as well as in the appendix on the geological history and physiography of the island.

A Naturalist in Cuba makes very interesting reading and disperses knowledge. It helps keep natural history alive.

Biological Field Stations of the World. By HOMER A. JACK. Waltham, Mass.: The Chronica Botanica Co.; New York: G. E. Stechert and Co. Chronica Botanica, 9 (1), 1945: 1–73. $2.50.—The purpose and history of the biological field stations of the world are appreciatively and informatively presented in this booklet, along with a discussion of the stations, as a group, in respect to their location, administration, equipment, living facilities, and, at greater length, their instruction and research. Available details regarding each station—founding date, location, affiliations, director, facilities, publications, etc.—are given in the 34-page Directory of Biological Stations. None of the stations are described at great length, but an effort was obviously made to render the listing complete, up to the start of the war which was ending as the treatise was published. The chief omissions that I note are of certain fishery research stations. European institutions of this type were discussed by William E. Ricker in The Progressive Fish Culturist (U. S. Bureau of Fisheries), Nos. 31, 32, 34 and 35 (1937–38). The author has done biology and biologists a very real service and it is to be hoped that he may fulfill his expressed wish of preparing a post-war edition.

SECTION ON GENETICS AND EVOLUTION

THE ENVIRONMENTAL CONDITIONS AFFECTING THE GENETIC MECHANISM OF WING PRODUCTION IN THE CHRYSANTHEMUM APHID[1]

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AT least one species of aphid has been shown in a series of studies (Shull, 1926 to 1938) to be suitable for morphogenetic studies, and there is abundant indication that other species may be so. Entomologists and others have published numerous articles proving the effects of temperature, nutrition and light, but for the most part the effects of these agents were not sharp enough.

The earlier literature has been reviewed by Shull (1929). During recent years the most extensive experiments under controlled conditions were those of Shull (1926 to 1938) in which change in frequency of wing production in *Macrosiphum solanifolii* afforded a distinct and easily measured response to the effects of various agents. Of these factors, he found light and temperature to be the most effective. Nutrition exerted some influence, for Shull (1928) found that starvation during a period of darkness increased the number of alatae. For *Macrosiphum pisi,* Schaefer (1938) reported that the number of alatae produced is inversely proportional to the ability of the plant to support its population. The water balance in the insect's body was considered the decisive factor by Rivnay (1937), while Thomas and Vevai (1940) believed low relative humidities accelerate wing formation.

Some features of the life cycle are relatively independent of the environment. Shull (1935) found that in *Macrosiphum solanifolii* the winged offspring became less

[1] Contribution from the Department of Zoology, the University of Michigan, Ann Arbor.

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numerous as the parents grew older, and that wingless parents had a greater tendency to produce winged progeny than winged parents had. The form of the parent was found to be significant also by Ackerman (1926) working on *Rhopalosiphum prunifoliae,* and by Schaefer (1938) on *Macrosiphum pisi.* Strong suggestion of inherited differences in wing production was provided by experiments of Shull (1932, 1943) in which different strains of the same species responded very differently.

Stocks

The strain of aphids of the species *Macrosiphum sanborni* used in these experiments was collected from a local garden in Ann Arbor in the fall of 1937. One substrain was kept under ordinary laboratory conditions of fluctuating temperature and in natural daylight and darkness. Two other substrains were kept in constant temperature cabinets in continuous (electric) light at temperatures of 18° C. and 22° C. respectively. All aphids lived on chrysanthemum plants.

Experimental Results

A. *Effects of various light intervals (temperature uncontrolled).* The results of preliminary experiments set up to ascertain the response to various periods of light and darkness, to continuous light and to continuous darkness are presented in Table 1. The parents were wingless and had been taken from room stock. Intervals of light varying from 22 hours of light out of 24 hours, 20 out of 24, 18 out of 24, etc., on down to 2 hours out of 24, were used, as well as continuous light and continuous darkness.

From Table 1 it is clear that the highest percentages of winged progeny are produced by parents reared in continuous light or in the longer intervals of light out of a 24-hour period, the proportion decreasing somewhat irregularly as the light interval is reduced down to 8 hours of light out of 24. At light intervals shorter than 8 hours,

including the extreme of continuous darkness, no winged progeny were produced. Eight hours of light, then, approximates the threshold.

In the later experiments these results appeared to justify limiting the light conditions to those of continuous light, 16 hours of light to 8 hours of darkness, and 8 hours of light to 16 hours of darkness. These periods repre-

TABLE 1

THE PERCENTAGES OF WINGED OFFSPRING PRODUCED UNDER VARIOUS LIGHT CONDITIONS AT ROOM TEMPERATURE BY WINGLESS PARENTS TAKEN FROM ROOM STOCK

Treatment of parents	Offspring		
No. hours light out of 24 hours	Wingless	Winged	Percentage winged
24	282	20	6.6
22	135	7	4.9
20	154	6	3.7
18	177	5	2.7
17	170	4	2.3
16	165	4	2.4
15	186	7	2.6
14	141	3	2.0
13	269	5	1.8
12	209	4	1.8
11	152	1	0.6
10	97	0	0
8	241	2	0.8
7	176	0	0
6	142	0	0
5	179	0	0
4	184	0	0
2	133	0	0
0	141	0	0

sent the limits of effectiveness and an intermediate condition.

B. *Effects of light with temperature controlled.* Following the preliminary experiments, tests were made with the temperature controlled. Wingless parents were taken from each of three stock lines which had been reared at 18° C. in continuous light, at 22° C. in continuous light, and at room (fluctuating) temperature in natural daylight and darkness, respectively. The aphids from each of these sources were divided into four groups, one raised at 12° C., one at 18° C., a third at 22° C., and the last at room temperature. At each of these temperatures, some aphids were given continuous light, other aphids 16 hours of light and 8 hours of darkness daily, and still others 8 hours of light and 16 hours of darkness daily.

Thirty-six groups of parent aphids were thus necessary for a complete series of experiments.

The results of these tests are presented in Table 2. The temperature and light conditions under which the stocks were reared are shown in the first two columns; the temperature and light conditions under which the

TABLE 2

THE PERCENTAGES OF WINGED OFFSPRING PRODUCED UNDER VARIOUS COMBINATIONS OF LIGHT AND TEMPERATURE CONDITIONS BOTH BEFORE AND DURING THE EXPERIMENTS. INFLUENCE OF LIGHT DURING EXPERIMENTS MOST DIRECTLY SHOWN

Parents				Offspring		
From stock reared at		Conditions under which reared		Wingless	Winged	Percentage winged
Temp. °C	Light	Temp. °C.	Light			
18°	Continuous	12°	Continuous	186	104	35.8
			16–8	280	118	29.6
			8–16	56	0	0
		18°	Continuous	316	30	8.6
			16–8	298	10	3.2
			8–16	303	0	0
		22°	Continuous	176	7	3.8
			16–8	81	5	5.8
			8–16	67	0	0
		Room	Continuous	157	8	4.6
			16–8	158	9	5.1
			8–16	55	0	0
22°	Continuous	12°	Continuous	432	117	21.3
			16–8	103	14	11.9
			8–16	140	2	1.4
		18°	Continuous	103	4	3.7
			16–8	121	5	4.2
			8–16	98	0	0
		22°	Continuous	316	16	4.9
			16–8	387	18	4.4
			8–16	361	0	0
		Room	Continuous	126	3	2.4
			16–8	93	4	4.1
			8–16	112	0	0
Room temp.	Natural daylight and darkness	12°	Continuous	310	18	5.5
			16–8	317	15	4.5
			8–16	296	2	0.7
		18°	Continuous	211	5	2.3
			16–8	230	12	4.9
			8–16	183	1	0.5
		22°	Continuous	214	15	6.5
			16–8	240	21	8.0
			8–16	209	2	0.9
		Room	Continuous	482	25	4.9
			16–8	515	27	4.9
			8–16	467	3	0.6

parents were reared in the experiment are shown in the third and fourth columns. The total numbers of winged and wingless offspring born of these 36 groups of parents are given in the fifth and sixth columns, and the percentage of winged individuals in the last column.

The data are so arranged in Table 2 as to indicate best

the effect of light on the percentage of winged progeny obtained. In branching tables, the contrasting conditions placed nearest the data (nearest to the right side of the chart) are the ones whose effect is best shown, since groups of adjoining numbers represent the contrast. The same data will be rearranged several times in the tables that follow, depending upon the agents to be contrasted.

In Table 2 it is clearly shown that regardless of the temperature employed during the experiment, eight hours of light produced few or no winged progeny, and always fewer than that produced by the longer light intervals. This was true for parents taken from each of the stock lines. Continuous light during the experiment often produced considerably higher percentages of winged aphids than did 16 hours of light. When the percentages produced by 16 hours of light were the higher, however, the differences were nearly always less. In general, there appears to be a trend in the data indicating that the longer periods of light resulted in the higher percentages of winged offspring.

C. *Effects of temperature.* In Table 3 the data are so arranged as to show best the effects of the temperatures at which the parents were reared. This is done by placing the four contrasted temperature conditions, namely, 12° C., 18° C., 22° C. and room (fluctuating) temperature, in the fourth column so that adjoining percentages in the last column of the table show that contrast directly.

It may readily be seen from Table 3 that the lowest temperature (12° C.) prevailing during the experiment is the one which induced the most winged offspring in parents taken from either the 18° stock or the 22° stock, regardless of the light conditions under which the parents were reared. Among parents taken from the room stock, however, those reared at 22° C. produced more wings than did those reared at any other temperature.

There was a sharp decrease in the number of winged progeny as the temperature was raised from 12° C. to

18° C., particularly when the light was either continuous or 16 hours long. For the 8-hour light period the number of winged progeny, if any, was always small. In every test except one (namely, parents from the 18° stock reared in continuous light) more winged aphids were

TABLE 3

THE PERCENTAGES OF WINGED OFFSPRING PRODUCED UNDER VARIOUS COMBINATIONS OF LIGHT AND TEMPERATURE CONDITIONS BOTH BEFORE AND DURING THE EXPERIMENTS. INFLUENCE OF TEMPERATURE DURING EXPERIMENTS MOST DIRECTLY SHOWN

Parents				Offspring		
From stock reared at		Conditions under which reared		Wingless	Winged	Percentage winged
Temp. °C.	Light	Light	Temp. °C			
18°	Continuous	Continuous	12	186	104	35.8
			18	316	30	8.6
			22	176	7	3.8
			Room	157	8	4.6
		16–8	12	280	118	29.6
			18	298	10	3.2
			22	81	5	5.8
			Room	158	9	5.1
		8–16	12	56	0	0
			18	303	0	0
			22	67	0	0
			Room	55	0	0
22°	Continuous	Continuous	12	432	117	21.3
			18	103	4	3.7
			22	316	16	4.9
			Room	120	3	2.4
		16–8	12	103	14	11.9
			18	121	5	4.2
			22	387	18	4.4
			Room	93	4	4.1
		8–16	12	140	2	1.4
			18	98	0	0
			22	361	0	0
			Room	112	0	0
Room temp.	Natural daylight and darkness	Continuous	12	310	18	5.5
			18	211	5	2.3
			22	214	15	6.5
			Room	482	25	4.9
		16–8	12	317	15	4.5
			18	230	12	4.9
			22	240	21	8.0
			Room	515	27	4.9
		8–16	12	296	2	0.7
			18	183	1	0.5
			22	209	2	0.9
			Room	467	3	0.6

produced by parents reared at 22° C. than by those reared at 18° C., regardless of other conditions. Among these results, however, the differences are often so small as to be of doubtful significance.

It may be said in general that at lower temperatures

the stimulating effect of long light periods is not interfered with; perhaps the lower temperatures actually enhance the stimulation. But as higher temperatures are used, an inhibiting action appears to affect the result which otherwise might have been expected from the light treatment. More will be said in section E regarding the effects of combinations of these agents.

D. *Effects of stock conditions.* For some of the experimental animals, the conditions under which they were reared represented merely a continuation of their former environment. For others the experimental conditions represented a change in temperature or light or both. It is desirable to know whether mere change, as such, has an effect. If there is a significant difference in proportion of winged progeny after a change in one or more environmental agents and if that difference is found to exist regardless of the direction of the change, then the presence or absence of the change may be held responsible for influencing wing production.

In Table 4 the data are so arranged as to show most directly the effect of antecedent conditions. Most striking is the especially great effect at the longer light periods of a drop from 18° C. stock temperature to 12° C. experimental temperature, and the smaller but still marked effect of a drop from 22° C. to 12° C. Here the temperature change may be held responsible for the increase in wing production.

An increase in the number of winged aphids produced did not always follow, however, a change in temperature, for in two instances more wings were produced when the stock and the experimental temperatures were the same than when they were different. This was true for 18°-stock parents reared at 18° C. (in contrast to 22°-stock parents reared at 18° C.) in continuous light, and for 22°-stock parents reared at 22° C. (in contrast to 18°-stock parents reared at 22° C.) in continuous light. (Interestingly enough the changes in temperature in the two sets of contrasts are in opposite directions.)

Moreover, it is difficult to attribute the response to mere change when it is noted that, other factors being identical, the 18°-stock parents six times out of nine produced higher percentages of winged aphids than did the 22°-stock parents, and the parents chosen from room stock

TABLE 4

THE PERCENTAGE OF WINGED OFFSPRING PRODUCED UNDER VARIOUS COMBINATIONS OF LIGHT AND TEMPERATURE BOTH BEFORE AND DURING THE EXPERIMENTS. INFLUENCE OF STOCK CONDITIONS MOST DIRECTLY SHOWN

Parents				Offspring		
Conditions under which reared		From stock reared at		Wingless	Winged	Percentage winged
Light	Temp. °C.	Temp. °C.	Light			
Continuous	12	18	Continuous	186	104	35.8
		22	Continuous	432	117	21.3
		Room	Natural	310	18	5.5
	18	18	Continuous	316	30	8.6
		22	Continuous	103	4	3.7
		Room	Natural	211	5	2.3
	22	18	Continuous	176	7	3.8
		22	Continuous	316	16	4.9
		Room	Natural	214	15	6.5
	Room	18	Continuous	157	8	4.6
		22	Continuous	120	3	2.4
		Room	Natural	482	25	4.9
16–8	12	18	Continuous	280	118	29.6
		22	Continuous	103	14	11.9
		Room	Natural	317	15	4.5
	18	18	Continuous	298	10	3.2
		22	Continuous	121	5	4.2
		Room	Natural	230	12	4.9
	22	18	Continuous	81	5	5.8
		22	Continuous	387	18	4.4
		Room	Natural	240	21	8.0
	Room	18	Continuous	158	9	5.1
		22	Continuous	93	4	4.1
		Room	Natural	515	27	4.9
8–16	12	18	Continuous	56	0	0
		22	Continuous	140	2	1.4
		Room	Natural	296	2	0.7
	18	18	Continuous	303	0	0
		22	Continuous	98	0	0
		Room	Natural	183	1	0.5
	22	18	Continuous	67	0	0
		22	Continuous	361	0	0
		Room	Natural	209	2	0.9
	Room	18	Continuous	55	0	0
		22	Continuous	112	0	0
		Room	Natural	467	3	0.6

surpassed eight times out of twelve the parents chosen from the 22° stock. There are several instances where the room stock produced under identical experimental conditions more wings than did either the 22° or the 18° stock. This happened when the parents were reared in continuous light at either 22° C. or at room temperature,

also when the light period for the parents was 16 hours long and the experimental temperature either 18° C. or 22° C.

Obviously caution must be used in basing any conclusions on these contradictory trends. Small differences may mean nothing; only where they are all in the same direction do they seem very convincing. Conclusions must rest on the larger differences.

E. *Effects of light and temperature combined.* It was desirable to know more about how temperature and light act in combination with each other—whether their combined effect is the algebraic sum of their single effects, or whether the action of one agent might change not merely in amount but even in sign, in response to changes in other factors.

To get this information, experiments were devised using various light intervals and various temperatures in several types of combinations. The experiments may be classified as to light periods into those of continuous light, 16 hours of light and 8 hours of darkness daily, and 8 hours of light and 16 hours of darkness daily, as these three combinations were known from previous tests to have different effects, thus permitting a not too slow accumulation of data.

The two temperatures used were 18° C. and 24° C. The aphids reared in continuous light were divided into four groups, depending upon the temperature treatment:

(1) Those kept at the low temperature, 18° C., throughout the experiment.
(2) Those kept at the high temperature, 24° C., throughout the experiment.
(3) Those kept 16 hours at the low and 8 hours at the high temperature.
(4) Those kept 16 hours at the high and 8 hours at the low temperature.

In the tests using 16 hours of light and 8 hours of darkness, there were six sets of temperature conditions:

(1) Those kept at the low temperature throughout the experiment.
(2) Those kept at the high temperature throughout the experiment.
(3) Those in which the 16 hours of light coincided with 16 hours of exposure to the low temperature, while the 8 hours of darkness coincided with 8 hours of high temperature.
(4) Those in which the 16 hours of light coincided with 16 hours of high-

temperature treatment; the 8 hours coincided with the 8 hours of low temperature.

(5) Those in which the 16-hour light period was broken up into a low-temperature period of 8 hours and a high-temperature period of 8 hours, while the 8-hour dark period was at low temperature.

(6) Those in which the 16-hour light period was again divided equally between the two temperatures, but with the 8-hour dark period at the high temperature.

Six corresponding temperature conditions were set up for the experiments involving 8 hours of light and 16 hours of darkness, making a total of sixteen sets of experiments for each type of stock; the two stocks tested, 18° C. and 22° C., made a total of 32 different experiments in the series.

The results are presented in Table 5. Here it is shown clearly that when the light conditions are conducive to wing production (*i.e.*, 16 or more hours of light out of a 24-hour period) the low temperature enhanced (or at least did not interfere with) that light effect. This can be seen in the table in every situation where the experimental conditions combined either continuous light or 16 hours of light with either constant exposure to low temperature or 16 hours of exposure to low temperature. This generalization holds true for experiments in which the parent aphids were taken from stocks reared at either 18° C. in continuous light or at 22° C. in continuous light.

In every case where the experimental factors other than temperature were identical, the high temperature resulted in a lower percentage of wings. But even a high temperature did not completely prevent some wings being formed if the light period allowed for wing production. When, however, the light period was too short to result in wings (8 hours), no exposure, however long, to low temperature succeeded in producing them.

It is possible, therefore, to consider long light periods and low temperature as positive wing-producing agents, and short light periods and high temperature as negative wing-producing agents. In experiments where the light period was conducive to wings and the temperature was

TABLE 5

THE PERCENTAGES OF WINGED OFFSPRING PRODUCED UNDER VARIOUS COMBINATIONS OF LIGHT AND TEMPERATURE BOTH BEFORE AND DURING THE EXPERIMENTS. INFLUENCES OF LIGHT AND TEMPERATURE DURING THE EXPERIMENTS MOST DIRECTLY SHOWN

Parents				Offspring		
From stock reared at		Conditions under which reared		Wingless	Winged	Percentage winged
Temp. °C.	Light	Light	Temperature °C.			
18°	Cont.	Cont.	18° constant	316	30	8.6
			24° constant	189	7	3.6
			16 hours at 18° 8 hours at 24°	62	3	4.6
			16 hours at 24° 8 hours at 18°	172	4	2.3
		16–8	18° constant	298	10	3.2
			24° constant	105	8	0.7
			16 hours light at 18° 8 hours dark at 24°	126	2	1.6
			16 hours light at 24° 8 hours dark at 18°	178	2	1.1
			8 hours light at 18° 8 hours light at 24° 8 hours dark at 18°	194	2	1.0
			8 hours light at 18° 8 hours light at 24° 8 hours dark at 24°	259	2	0.8
		8–16	18° constant	303	0	0
			24° constant	55	0	0
			8 hours light at 18° 16 hours dark at 24°	261	1	0.8
			8 hours light at 24° 16 hours dark at 18°	70	0	0
			8 hours light at 18° 8 hours dark at 18° 8 hours dark at 24°	103	0	0
			8 hours light at 24° 8 hours dark at 18° 8 hours dark at 24°	114	0	0
22°	Cont.	Cont.	18° constant	103	4	3.7
			24° constant	120	3	2.4
			16 hours at 18° 8 hours at 24°	125	4	3.3
			16 hours at 24° 8 hours at 18°	211	5	2.3
		16–8	18° constant	121	5	4.2
			24° constant	112	2	1.7
			16 hours light at 18° 8 hours dark at 24°	101	3	2.8
			16 hours light at 24° 8 hours dark at 18°	40	1	2.4
			8 hours light at 18° 8 hours light at 24° 8 hours dark at 18°	94	2	2.1
			8 hours light at 18° 8 hours light at 24° 8 hours dark at 24°	183	1	0.5
		8–16	18° constant	98	0	0
			24° constant	112	0	0
			8 hours light at 18° 16 hours dark at 24°	103	0	0
			8 hours light at 24° 16 hours dark at 18°	174	0	0
			8 hours light at 18° 8 hours dark at 18° 8 hours dark at 24°	164	0	0
			8 hours light at 24° 8 hours dark at 24° 8 hours dark at 18°	182	1	0.6

not, or *vice versa,* the effects appeared to cancel each other. This was true whether the antagonistic agents were acting on the aphids at the same time or at different times. The length of the period which the agent had to act in was the factor that decided how great its influence was to be. In experiments where there was a total exposure of 24 hours to negative agents (counting 8 hours exposure to two negative agents at the same time as 16 hours), there were usually fewer wings produced than in experiments where there was a shorter total exposure to negative agents. Moreover, an exposure of 16 hours to negative agents always resulted in fewer wings than did an 8-hour exposure to negative agents.

F. *Influence of the form of the parent.* The number of winged aphids produced in *Macrosiphum sanborni* is seldom large. Experiments using winged parents were set up as such individuals appeared incidentally in the other experiments, and such tests had to be fitted in with those already in progress. Consequently, only rather meager information is offered here regarding the effect of wings or their absence in the parents upon wing production in the offspring.

The data are so arranged in Table 6 as to show best whatever difference there was in the tendency of wingless and winged parents to produce winged offspring. Of the 28 contrasts shown in the last column, the wingless parents yielded more winged offspring in 16, and fewer winged offspring in 12. Unusually large differences are found in percentages of winged aphids produced by 18°-stock winged and wingless parents reared at 12° C. in either continuous light or 16 hours of light. Not as large, but still striking, are the differences in percentages of winged aphids produced by 22°-stock parents reared at 12° C. in either continuous light or 16 hours of light. Under these conditions wingless parents produced far more winged progeny than did winged parents.

There thus appeared to be a tendency for wingless aphids to produce the more winged offspring when the

TABLE 6

THE PERCENTAGES OF WINGED OFFSPRING PRODUCED BY WINGED AND WINGLESS PARENTS UNDER VARIOUS COMBINATIONS OF LIGHT AND TEMPERATURE CONDITIONS BOTH BEFORE AND DURING THE EXPERIMENTS. INFLUENCE OF WINGS OR THEIR ABSENCE IN THE PARENTS MOST DIRECTLY SHOWN

Parents				Offspring		
From stock reared at	Conditions under which reared: Light	Conditions under which reared: Temperature °C.	Form of parent	Wingless	Winged	Percentage winged
18° C. in continuous light	Cont.	12°	Wingless	186	104	35.8
			Winged	81	3	3.6
		18°	Wingless	316	30	8.6
			Winged	41	2	4.7
		22°	Wingless	176	7	3.8
			Winged	35	3	7.9
		16 hrs. at 18°, 8 hrs. at 24°	Wingless	62	3	4.6
			Winged	56	3	5.1
		Room	Wingless	157	8	4.6
			Winged	309	10	3.1
	16–8	12°	Wingless	280	118	29.6
			Winged	49	3	5.8
		18°	Wingless	298	10	3.2
			Winged	50	2	3.8
		22°	Wingless	81	5	5.8
			Winged	85	9	9.6
		16 hrs. light at 18°, 8 hrs. dark at 24°	Wingless	126	2	1.6
			Winged	39	1	2.5
		Room	Wingless	158	9	5.1
			Winged	96	6	5.9
22° C. in continuous light	Cont.	12°	Wingless	432	117	21.3
			Winged	56	9	13.8
		18°	Wingless	103	4	3.7
			Winged	44	2	4.3
		22°	Wingless	316	16	4.9
			Winged	161	3	1.8
		16 hrs. at 18°, 8 hrs. at 24°	Wingless	125	4	3.3
			Winged	19	1	5.0
		Room	Wingless	120	3	2.4
			Winged	105	2	1.9
	16–8	12°	Wingless	103	14	11.9
			Winged	70	5	6.7
		18°	Wingless	121	5	4.2
			Winged	17	0	0
		22°	Wingless	387	18	4.4
			Winged	75	6	7.4
		16 hrs. light at 18°, 8 hrs. dark 24°	Wingless	101	3	2.8
			Winged	51	1	1.9
		Room	Wingless	93	4	4.1
			Winged	204	3	1.4
Room temp. in natural daylight and darkness	Cont.	12°	Wingless	310	18	5.5
			Winged	31	1	3.1
		18°	Wingless	211	5	2.3
			Winged	57	2	3.4
		22°	Wingless	214	15	6.5
			Winged	42	1	2.3
		Room	Wingless	482	25	4.9
			Winged	135	8	5.6
	16–8	12°	Wingless	317	15	4.5
			Winged	47	3	6.0
		18°	Wingless	230	12	4.9
			Winged	19	0	0
		22°	Wingless	240	21	8.0
			Winged	76	3	3.8
		Room	Wingless	515	27	4.9
			Winged	124	4	3.1

parents were reared at 12° C. in the longer periods of light. Where the tendency appeared for wings in the parent to favor wings in the progeny, the differences were much less striking and were presumably less significant. In general, the winged parents produced more uniform percentages of winged aphids; the percentages seldom varied with the light and temperature conditions to the extent that those for wingless parents often did.

G. *Effects of wilting of the plant.* The last of the influences to be tested was that of the condition of the host plant. In this series of experiments aphids were reared on plants that were allowed to wilt from lack of water until the leaves and tips of the stems drooped. Soon after being watered the plants would revive for a short time and then wilt again. During these changes in the plant, the parent aphids were undisturbed until a suitable number of young had appeared, whereupon the parents were transferred to new plants which were then subjected to the same wilting treatment. The progeny remained on the original plant, but after the parents had been removed, the plants were not permitted to wilt.

In the first series of wilting experiments the animals were kept at the same experimental temperature as had been the stocks from which they were taken. Among the aphids at any one experimental temperature, the light period during the experiment was the only variable factor.

In the second series the aphids were kept at a temperature different from the one at which their parents had been reared. The various light periods corresponded to those in the first series, so that among the aphids in either series at any one current temperature and light period, the only variable was the antecedent temperature.

It should be noted that not all these experiments were carried on simultaneously, but were necessarily conducted over different times of the year. This fact undoubtedly introduced one or more important uncontrolled factors. The highest percentages of winged offspring in the entire research were obtained in March, 1940. Several attempts

later in the year to repeat these large numbers were unsuccessful, and all experiments were discontinued before the spring of 1941.

The results of all the wilting experiments in both series are combined and presented in Table 7 in such a way as to facilitate comparison of the effects on wing production of fresh and wilted host plants. Very large percentages of winged aphids were produced by 18°-stock parents reared at 12° C. in either continuous light or 16 hours of light, and by 22°-stock parents reared at 12° C. in either continuous light or 16 hours of light. Under these conditions much larger percentages of winged progeny were obtained from parents reared on fresh plants than from those reared on wilted plants.

In other combinations of stock and current conditions, the results were inconsistent. Often more winged aphids were produced on wilted plants than on fresh ones, though the differences were much less marked than those just pointed out.

There appears to be no general rule stating the relations between the host plant and the degree of wing production, especially when one remembers the uncontrolled seasonal factor. Moreover, until these insects can be induced to feed on artificial media, it will be uncertain just how much of their response is due to simple nutrition and how much to other factors.

Development of Wing Buds

The time of determination and time of differentiation of wings in *Macrosiphum solanifolii* have been studied by Shull (1938). In this species the early stages of wing development consist of thickenings of the hypodermis in the dorsolateral regions of the thorax. The time of differentiation was accurately ascertained. Whether a potato aphid of a favorable strain is to be winged or wingless can be known with reasonable certainty from the light and temperature treatment it has received. Embryos destined to become wingless adults have the wing buds in

TABLE 7

THE PERCENTAGES OF WINGED OFFSPRING PRODUCED ON FRESH AND WILTED HOST PLANTS BY WINGLESS PARENTS UNDER VARIOUS LIGHT AND TEMPERATURE CONDITIONS. INFLUENCE OF THE HOST PLANT MOST DIRECTLY SHOWN

Parents					Offspring		
From stock reared at		Conditions under which reared					
Temp. °C.	Light	Temp. °C.	Light	Plant	Wingless	Winged	Percentage winged
18°	Cont.	12°	Cont.	Fresh	11	101	90.1
				Wilted	62	28	31.1
			16–8	Fresh	21	59	73.8
				Wilted	51	20	28.2
			8–16	Fresh	43	0	0
				Wilted	66	0	0
		18°	Cont.	Fresh	169	18	9.6
				Wilted	106	10	8.6
			16–8	Fresh	195	12	5.8
				Wilted	98	4	3.9
			8–16	Fresh	121	0	0
				Wilted	183	0	0
		22°	Cont.	Fresh	89	9	9.2
				Wilted	74	3	3.8
			16–8	Fresh	44	10	18.5
				Wilted	51	3	5.1
			8–16	Fresh	31	0	0
				Wilted	117	0	0
		Room	Cont.	Fresh	44	4	8.3
				Wilted	62	3	4.6
			16–8	Fresh	50	1	1.9
				Wilted	63	4	5.9
			8–16	Fresh	40	0	0
				Wilted	75	0	0
22°	Cont.	12°	Cont.	Fresh	40	82	67.2
				Wilted	63	17	21.3
			16–8	Fresh	61	18	22.8
				Wilted	57	7	10.9
			8–16	Fresh	84	0	0
				Wilted	71	1	1.4
		18°	Cont.	Fresh	100	5	4.8
				Wilted	194	2	1.0
			16–8	Fresh	64	1	1.5
				Wilted	121	4	3.2
			8–16	Fresh	61	0	0
				Wilted	108	0	0
		22°	Cont.	Fresh	70	1	1.4
				Wilted	39	2	4.9
			16–8	Fresh	45	1	2.2
				Wilted	53	2	3.6
			8–16	Fresh	51	0	0
				Wilted	314	0	0
		Room	Cont.	Fresh	112	2	1.7
				Wilted	118	3	2.5
			16–8	Fresh	85	0	0
				Wilted	95	5	5.0
			8–16	Fresh	64	0	0
				Wilted	121	0	0
Room	Natural daylight and darkness	12°	Cont.	Fresh	307	14	4.4
				Wilted	285	18	5.9
			16–8	Fresh	101	2	1.9
				Wilted	200	6	2.9
			8–16	Fresh	57	0	0
				Wilted	42	0	0
		18°	Cont.	Fresh	223	5	2.2
				Wilted	296	4	1.3
			16–8	Fresh	227	11	4.6
				Wilted	387	18	4.4
			8–16	Fresh	109	0	0
				Wilted	114	0	0
		22°	Cont.	Fresh	183	11	5.6
				Wilted	237	13	5.2
			16–8	Fresh	94	2	2.1
				Wilted	91	0	0
			8–16	Fresh	75	0	0
				Wilted	291	2	0.7
		Room	Cont.	Fresh	40	1	2.4
				Wilted	482	18	3.6
			16–8	Fresh	516	26	4.8
				Wilted	82	2	2.4
			8–16	Fresh	39	0	0
				Wilted	458	5	1.1

typical position before birth but these disappear before the end of the first instar, probably early in that instar. In embryos which will become winged, the further growth and thickening of the buds which lead to wings begin a short time before birth. It has been found that the beginning of definitive wing development very closely follows the first production of eye pigment, and that the latter starts on the average about 26 hours before birth. About 22 to 24 hours before birth is probably the time at which the wing buds begin thickening.

It is unfortunate for this phase of the problem that in *Macrosiphum sanborni* it is not possible to say from the treatment it had received that a certain young individual would have become winged as an adult no matter what the histological examination showed. No treatment in this research was found that produced 100 per cent. winged progeny, and the highest percentages that were obtained could not always be repeated.

An attempt was made to find wing buds in the chrysanthemum aphid. Sections through unborn embryos in parents taken from room stock revealed no wing rudiments. Moreover, sections through unborn embryos in parents reared under conditions which produced a fairly high percentage of wings showed no signs of wing buds. Any hypodermal thickenings present were only slight and exhibited no definite contours or continuity over a series of successive sections. It is possible that the embryos that were examined would have developed into wingless adults, but this prophecy is not a certain one.

In the potato aphid, then, the embryos start out with wing buds. Whether they develop into winged or wingless adults depends largely on the light and temperature conditions under which they are reared. A wingless adult of this species may be thought of as being the result of certain inhibitions imposed upon its normal tendency toward wingedness.

The chrysanthemum aphid has no such inclination toward wing development. Young embryos appear not to

have wing rudiments, and high percentages of winged adults are never obtained among uncontrolled cultures. The "normal" condition for this species is winglessness and a winged individual represents a response to certain stimulating factors which have succeeded in overcoming an inherent "reluctance" to form wings.

The inhibition of wings in *Macrosiphum solanifolii* and the stimulation of them in *Macrosiphum sanborni* could some time afford a clue to the physiological mechanism of wing development, but the present data scarcely furnish a basis of an explanation.

Discussion

A. *The life cycle of aphids.* The life cycle of aphids is usually described as involving in the spring or early summer winged individuals by which migration occurs from the primary to the intermediate host, followed during the summer by an indefinite number of generations of wingless females, these in turn succeeded during the late summer and early autumn by more winged aphids which return to the primary host.

For species which conform to this annual routine, the changes in light, temperature and nutrition attendant upon the seasons are the obvious features of the environment which might be held responsible for the recurring alterations through which these life cycles pass. The lengthening of the days in spring and their shortening in late summer, the rise and fall in daily mean temperatures, and the increase and subsequent decrease in the quantity of succulent foliage available for food are all factors to which these cyclical fluctuations might reasonably be attributed in a "typical" species.

In the case of a species which does not exhibit with the seasons such regular changes in the proportion of winged and wingless individuals the task of explaining the determination of types of individuals is much more difficult. In *Macrosiphum sanborni* there appears to be no rhythmical succession of peaks and depressions of wing produc-

tion; and it is evident that for this and similar species no explanation based on climatic causes alone could be adequate.

B. *Rating of the effects of the factors tested on Macrosiphum sanborni.* The experiments on *Macrosiphum sanborni* have demonstrated repeatedly that every one of the agents tested, both environmental conditions and genetic or other internal factors, has a noticeable effect on wing production.

A weighting of their effects would assign without question a greater influence to the light conditions prevailing during the experiment (maximum production at 16 or more hours of light out of 24 hours) than to any other agent. Second place would be given to the temperature used during the experiment (12° C. being most stimulating to wing formation, the percentages decreasing with rise in temperature). Third rating would probably go to antecedent conditions of the stock (most striking increase in wing production following a drop to 12° C. experimental temperature at the longer light periods from either 18° C. or 22° C. stock temperatures). Form of the parent, whether winged or wingless, appears to be fourth in order (usually wingless parents surpassing the winged parents in wing production among their offspring). Fifth place belongs to the condition of the host plant, whether wilted or fresh, the lowest place being assigned to this agency because it acted very irregularly and was presumably modified by other factors.

C. *Comparison with the rating for Macrosiphum solanifolii.* The rating of the agents for *Macrosiphum sanborni* corresponds fairly well to the results obtained by Shull (1928, 1929, 1935) for *Macrosiphum solanifolii,* although the individual conditions differ considerably. For the potato aphid the light condition prevailing during the experiment was likewise first in importance, but alternating light and darkness were more effective than continuous light, with the maximum effect obtained by the ratio of six hours of light to twelve hours of darkness.

Temperature during the experiment was the second most important factor for the potato aphid as well as for the chrysanthemum aphid, although in the former species more winged offspring were produced at a moderately high temperature (though not at an extremely high one) than at a low one, the opposite of the situation in *Macrosiphum sanborni.* Wingedness or winglessness of the parents is third in effectiveness for the potato aphid, though its influence was striking only in parents taken from a low temperature stock. In that case, the winged parents produced notably fewer winged offspring than did the wingless parents. In *Macrosiphum sanborni,* also, more winged aphids were produced by wingless parents than by winged parents, though again the influence of the form of the parent was found to vary with antecedent conditions. Fourth rating in importance for the potato aphid was given to the temperature (light was not tested) applied to the parents before the beginning of the experiment, while for the chrysanthemum aphid antecedent conditions (both temperature and light) were assigned to third place because they appeared to be more influential than either the form of the parent or the nature of the host plant.

Starvation was found to induce wings in the potato aphid, provided the starvation occurred in the light rather than in darkness. These nutrition experiments must be compared with caution to those for *Macrosiphum sanborni* because the techniques used were so different. The potato aphids were starved by being removed from the plants and placed in vials stopped with cotton plugs; the chrysanthemum aphids were reared on wilted host plants.

Thus it is seen that the rating of the importance of the agents tested is quite similar in the two species of aphids, but that there is wide diversity between the species as to what condition of the agent proves most influential.

D. *A possible physiological interpretation.* For species which respond to light as does *Macrosiphum solanifolii,* it is scarcely necessary to utilize any factor other

than length of the light period to explain its cyclical changes, since the days of early spring and autumn are relatively short, those of summer longer. However, as Shull (1928) pointed out, it would be easy to overdo the environmental explanation of wings, for there is certainly something other than external factors that helps to produce them.

It is even more evident for *Macrosiphum sanborni* that no environmental explanation, using any or all external agents, alone is adequate. The necessity for a physiological interpretation involving both external and internal factors is obvious, but that does not prevent it from being hazardous to formulate.

It seems possible to assume that wing production in *Macrosiphum sanborni* is due to a substance which causes the tissues to grow and differentiate appropriately at the proper time in the wing bud region. It may be imagined that this substance, A, is produced in the light but, in darkness, is either converted into another substance, B, or else is consumed in some reaction or is otherwise eliminated. Formation of wings could be assumed to occur either when a given concentration of A is present or when the quantity of A bears a certain ratio to that of its conversion product.

The substance A may be thought of as a simple and direct product of the action of light, since in continuous light higher percentages of winged aphids are produced than in 16 hours of light, while 8 hours of light appears to be the length of time necessary to produce a threshold concentration of A.

Low temperature would be supposed to result in a greater concentration of A. This effect may be brought about by either an acceleration of the production of A or a retardation of the conversion of A into B, or both. In either case the greater concentration of A results in a higher percentage of wings. High temperature could be assumed to result in a smaller concentration of A. This may be due to the heat either inhibiting the production

of A or accelerating its conversion into B, or both. The end result is a smaller quantity of A and therefore a lower percentage of wings.

Even a high temperature does not completely prevent some wings being formed by the chrysanthemum aphid if the light period allows for production of a sufficient quantity of A. When, however, the light period is too short (eight hours or less) to allow for an adequate supply of A, no exposure, however long, to low temperature will succeed in producing wings. Alternations of high and low temperatures or of light and dark periods result in a confused effect that does not distinguish between the production and the conversion of A.

Expansion of this theory to fit the results of the experiments with other factors is done with caution. Thus in the experiments where more wings were produced by parents fed on fresh plants than by those on wilted ones, the results might plausibly be said to be due to a difference in the quantity or quality of A-producing material received by the insects in their food, fresh plants presumably being richer in the essential elements than wilted ones. The results of the majority of the nutrition experiments, however, were very irregular, and for them no general rule or explanation can be stated.

Whatever difference there is between winged and wingless parents in producing winged offspring is not a hereditary difference in a strict sense, but is probably due to some physiological difference intimately associated with the presence or absence of wings. It is modified by antecedent conditions to which the stock was exposed.

Furthermore, the variety of response exhibited by the different stock lines might be imagined to be due to an inherited difference in the ability to produce or utilize substance A in metabolism.

While such an explanation is obviously purely speculative, it has the advantage of requiring only a single mechanism through which all the environmental agents operate. Whether that mechanism can ever be identified is doubtful.

SUMMARY

(1) Approximately 29,000 chrysanthemum aphids (*Macrosiphum sanborni*) were reared under controlled conditions to study the effect of light, temperature, wilting of the host plant, presence or absence of wings in the parents and environment of the stock on wing production.

(2) Every one of the factors tested had a noticeable influence on wing production. A weighting of their effects would assign the greatest influence to the light conditions prevailing during the experiment. Second place would be given to the temperature used during the experiment. The environment of the stock from which the experimental animals were drawn is third in importance, followed by the presence or absence of wings in the parent aphids. The least effective of all the agents tested was the condition of the host plant, whether wilted or fresh.

(3) The highest percentages of winged progeny were produced by parents reared in continuous light or in the longer intervals of light out of a 24-hour period, the proportion decreasing (somewhat irregularly) as the interval was lessened down to eight hours of light out of 24. At light periods shorter than eight hours (including the extreme of continuous darkness), no winged progeny were produced.

(4) The lowest temperature, 12° C., prevailing during the experiment induced the most winged offspring. There was a sharp decrease in the number of winged progeny as the experimental temperature was raised from 12° C. to 18° C.

(5) At low temperatures the stimulating effect of long light periods was not interfered with, while higher temperatures appeared to exert an inhibiting action on wing production. In tests where the light period was conducive to wings and the temperature was not, or *vice versa*, one factor appeared in general to neutralize the developmental effect of the other. This was true whether the antagonistic agents were acting on the aphids at the same time or at different times. A high temperature

did not completely prevent, however, some wings being formed if the light period allowed for wing production; neither did any exposure to low temperature succeed in inducing wings if the light period were too short (eight hours or less) to permit their development.

(6) The antecedent conditions of light and temperature to which the stocks had been exposed before the experiments were found to have a significant influence on the development of wings. Sometimes the mere change from stock conditions to experimental conditions might be held responsible for the increase in wing production. (Thus, an especially great effect of a drop from 18° C. stock temperature to 12° C. experimental temperature, and a smaller but still marked effect of a drop from 22° C. to 12° C. were noted.) The differences in response can not all be attributed to the change itself, however, for, other factors being identical, the 22° stock usually produced lower percentages of winged offspring than did either the 18° or the room stock.

(7) There was a tendency for wingless parents to surpass winged parents in the production of winged aphids, provided the parents had come from 18° stock or 22° stock and were reared at 12° C. in either continuous light or 16 hours of light.

(8) Strikingly higher percentages of winged offspring were obtained from parents reared on fresh plants than on wilted ones under certain conditions. Under other conditions the results were so irregular as to throw doubt on the significance of the effect of the host plant.

(9) The highest percentage of winged progeny (90.1 per cent.) obtained in this research was from parents selected from stock reared at 18° C. in continuous light. The parents were subjected during the experiment to 12° C. temperature and continuous light and were reared on fresh plants. (This high number of winged aphids was obtained but once, and then during the month of March.)

(10) Sections through unborn embryos revealed no

wing buds; this was true even when the parents had been reared under conditions which might have been expected to produce a fairly high percentage of winged aphids. It is not known whether the embryos that were examined would have developed into winged or wingless adults.

(11) Winglessness is the usual condition for *Macrosiphum sanborni;* high percentages of winged adults are never obtained among uncontrolled cultures. A winged individual represents a response to certain stimulating agents which have succeeded in overcoming an inherent tendency toward winglessness.

(12) To explain the variety of response to current and antecedent conditions evidenced in wing production it is postulated that some substance, A, necessary for wing development is produced in the light and is converted into some other substance in the dark. Formation of wings occurs either when a given concentration of A is present or when the quantity of A bears a certain ratio to that of its conversion product. Low temperature results in a greater quantity of A either by an acceleration of the production of A or by a retardation of its conversion or both. The greater quantity of A present in parents is evidenced by higher percentages of winged progeny. High temperature either retards the production of A or hastens its conversion and therefore results in a lower percentage of winged offspring.

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NEW AMPHIDIPLOID SPECIES OF WHEAT AND THEIR SIGNIFICANCE FOR SELECTION AND EVOLUTION[1]

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THE fact is widely known that the different species of wheat (*Triticum*) form a polyploid series, and that *T. vulgare,* the species with the highest chromosome number, is also the most widely adapted to different environments. This fact has suggested to the writer that further improvement of wheat could be affected by increasing the chromosome number still further and by combining the genomes now present in cultivated wheats with additional ones from other species of *Triticum.* Accordingly, he has for seven years been conducting experiments on the production of new amphidiploid species, which have combined with genomes present in the ordinary 28-chromosome ("emmer") and 42-chromosome ("vulgare") series additional genomes derived from two species, *T. monococcum* L. and *T. Timopheevi* Zhuk. Both of these species possess valuable characteristics not present in the ordinary cultivated wheats. The valuable characters of *T. monococcum* are its non-lodging habit and its resistance to rust. This same resistance is particularly strongly expressed in *T. Timopheevi,* and is perhaps the most valuable characteristic of that species. Both species are genetically distinct from all other wheat species, forming highly sterile hybrids when crossed with any member of the emmer or vulgare series.

The various hybrids involving *T. monococcum* and the ordinary cultivated wheats have been described by a number of workers (*cf.* review by Aase, 1935). *T. Timopheevi* has the same chromosome number ($2n = 28$) as the emmer

[1] Paper delivered at the Division of Genetics, College of Agriculture, University of California, Berkeley, on June 12, 1945. Dr. Zhebrak was at this time a member of the Byelo-Russian delegation to the United Nations Conference.

series of wheats (*T. dicoccum, T. durum* and others), and the cytology of hybrids between these species and *T. Timopheevi* was studied by Kihara and Lilienfeld (1934). They found that one of the two genomes present in *T. Timopheevi* corresponds with the A genome of *T. durum* and the other emmer wheats, but that the other is totally different. They designated the latter G.

When the writer and his associates started their experiments, these facts were taken into account, and it was expected that the doubling of the chromosome number of the sterile hybrids would restore fertility, and would enable them to obtain new types of wheat with higher chromosome numbers. Therefore, starting in 1938, they obtained large numbers of hybrid seeds, subjected them to colchicine treatment, and obtained amphidiploid types of the following interspecific combinations: *T. durum* × *T. monococcum* (2n = 42), *T. durum* × *T. Timopheevi* (2n = 56), *T. turgidum* × *T. Timopheevi* (2n = 56), *T. persicum* × *T. Timopheevi* (2n = 56), *T. polonicum* × *T. Timopheevi* (2n = 56), *T. orientale* × *T. Timopheevi* (2n = 56), *T. polonicum* × *T. durum* (2n = 56), *T. vulgare* × *T. Timopheevi* (2n = 70), *T. durum* × *T. vulgare* (2n = 70).

Many different varieties and races of 28- and 42-chromosome species were used for the production of amphidiploids. Amphidiploids of 81 interspecific combinations from crosses in both directions have been obtained. If we include the amphidiploids obtained repeatedly from certain combinations in different years, the total number of amphidiploids of wheat obtained reaches a hundred. Compared with the total of all artificial amphidiploids obtained throughout the world, this is a relatively high number. If only varieties of 28-chromosome wheat which yielded amphidiploids from crosses with *T. Timopheevi* are taken into account, we have amphidiploids with 19 varieties of *T. durum,* 6 varieties of *T. turgidum,* 3 varieties of *T. persicum,* 3 varieties of *T. polonicum* and one variety of *T. orientale,* or a total of 32 varieties.

Descriptions of these amphidiploids have been given in several previous publications (Zhebrak, 1944a, 1944b, etc.; see 1944b for complete list).

Systematics of the Amphidiploids

The obtaining of a large number of wheats similar to each other in many taxonomic characters puts forward the problem of determining their place in the systematics of the genus *Triticum*. Our amphidiploid types of wheat satisfy the genetical concept of species in botany, proposed by Professor Babcock (1931). All our amphidiploids between *T. Timopheevi* and the other 28-chromosome species have the same number of chromosomes (56) and a whole series of other characters in common. The large number of amphidiploid types already obtained may be rapidly increased still further by intercrossing, as well as by mutation. All of them, however, have a similar origin, since they originated from crosses between *T. Timopheevi* and a series of interfertile types. They can be readily crossed among themselves, give fetrile hybrids, and the further process of development of forms proceeds in the direction of recombination of the specific traits of the parents. When they are crossed with other species differing in chromosome numbers or with species characterized by non-homologous genomes, the hybrid offspring are of low fertility. Due to the fact that these amphidiploids were obtained from sharply distinct types recognized by most botanists as species, they exhibit the differences between these five species. This is an adequate basis for assigning to the different amphidiploids subspecific rank (*cf.* Zhebrak, 1944b).

All the evidence which I have mentioned is sufficient basis for placing all the 56-chromosome amphidiploid types of wheat obtained as a result of crossing of five 28-chromosome species of wheat with *T. Timopheevi* into a separate species of wheat, *T. soveticum*. This we have done in our previous publications (Zhebrak, 1944a, b). According to the same reasoning, although somewhat less

justifiably, specific rank has been accorded to other amphidiploids: *T. durum-monococcum* and *T. vulgare-Timopheevi.*

Crossability and Hybridization of the Amphidiploids

In recent years we have made cyclic crosses between different subspecies and have established the following facts.

(1) The crosses are made relatively easily.

(2) First and subsequent generation hybrids are characterized by high fertility.

(3) In the second generation segregation into the parental species does not occur, but there is nevertheless a wide range of variation, including the recombination of specific and subspecific traits, with the appearance of new homozygous combinations of traits of the parental species and subspecies.

A distinctive biological property of the amphidiploid types is their ability for cross pollination. The ordinary cultivated wheat species are almost entirely self-pollinated. Only in isolated years and in certain varieties do we find a small fraction of a per cent. of hybrids from cross pollination. Most of our amphidiploid wheats produce every year a certain percentage of complex interspecific hybrids when grown in a seed plot with other species and varieties. Certain of the subspecies and varieties give a rather high percentage of complex hybrids. We have hybrids between the majority of our amphidiploids and other species. Considering that the amphidiploid combines two diploid complexes of chromosomes, the hybrid between the amphidiploid and *T. vulgare* is a trihaploid, while hybrids between two amphidiploids are tetrahaploids. The term trihaploid is used here in the sense of three haploid complexes of three different species, even if some of their chromosomes are homologous. Similarly, tetrahaploid refers to four such complexes. All these complex types were first obtained

by us; they never have existed nor do they now exist anywhere else. Therefore it is necessary to consider them at some length. It seems to me that two questions require some elaboration: the fertility of trihaploid and tetrahaploid wheat hybrids and the mode of action of dominant genes in these complex hybrids.

Hybrids of 56-chromosome amphidiploids with *T. vulgare* were obtained of the following types:

T. durum-Timopheevi × *T. vulgare*
T. turgidum-Timopheevi × *T. vulgare*
T. persicum-Timopheevi × *T. vulgare*
T. polonicum-Timopheevi × *T. vulgare*
T. orientale-Timopheevi × *T. vulgare*

All contain forty-nine chromosomes in their somatic cells.

Hybrids between different amphidiploids were obtained in the following combinations:

T. persicum-Timopheevi × *T. durum-monococcum*
T. durum-vulgare × *T. turgidum-Timopheevi*
T. polonicum-durum × *T. durum-Timopheevi*

We approached the cross between the amphidiploid *T. vulgare-durum* and the amphidiploid *T. vulgare-Timopheevi* with the special purpose of obtaining the segregation of the genomes of *T. Timopheevi.*

The fertility of all 49-chromosome hybrids is exceedingly low. It consists of one or two seeds per plant and fractions of a per cent. per spikelet. Thus in the hybrid *T. polonicum-Timopheevi* × *T. vulgare* eleven spikes with one hundred and eighty spikelets yielded three seeds or about one seed per hundred spikelets. Figures similar to these with respect to fertility appear in other trihaploid and tetrahaploid hybrids. In the hybrid *T. persicum-Timopheevi* × *T. durum-monococcum* not one seed set. In general trihaploid hybrids approach the fertility of the amphidiploid types which involve *T. Timopheevi.* Such low fertility of trihaploid and tetrahaploid hybrids permits the belief that by doubling their chromosome numbers fertility could be increased and even higher polyploid types of wheat created. Trihaploid wheat hybrids are vegetatively vigorous, bushy plants. The latter is, per-

haps, explained not only by the phenomenon of heterosis, but also by the fact that they are sterile and have a long stage of vegetative growth.

Our material on the complex hybrids of three and four species of wheat enables us to determine a series of complicated processes regarding the nature and power of action of individual dominant genes of the different species in these genotypic complexes. I shall point out several facts.

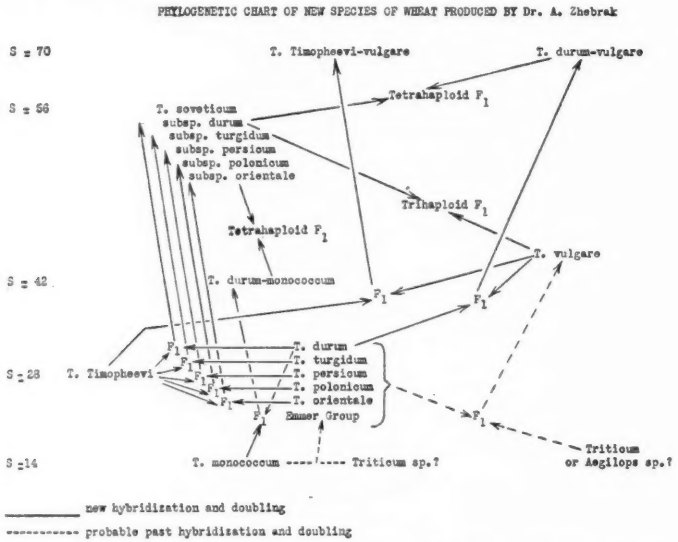

FIG. 1. Phylogenetic chart of new species of wheat produced by Dr. A. Zhebrak.

The hybrid between the amphidiploid *T. persicum-Timopheevi* and *T. vulgare* has a black spike, is awnless, and has a short tooth on the glume. The gene for black spike color is dominant to the white color of the spike of *T. Timopheevi.* In the trihaploid hybrid *T. persicum-Timopheevi* × *T. vulgare,* the dominant gene for black is coupled with a double dose of the recessive allele, and yet it is impossible to distinguish any difference in the degree of pigmentation of the spike. In the hybrids between two

amphidiploids (*T. persicum-Timopheevi* × *T. durum-Timopheevi*) the gene for the black color of spike is in combination with a triple dose of the recessive allele, but nonetheless the dominant action is not removed. In the tetraploid hybrids of two amphidiploids (*T. persicum-Timopheevi* × *T. durum-monococcum*) the genes for the black color of spike from *T. persicum* also express themselves, though they are opposed, so to say, by recessive alleles from three other species of wheat. In the same hybrids the angular notch between the teeth of the glume, characteristic of *T. monococcum*, is also very sharply expressed. The gene for this trait is expressed even in such a complex genotype as the one consisting of 14 chromosomes of *T. persicum*, 14 chromosomes of *T. Timopheevi*, 14 chromosomes of *T. durum* and only 7 chromosomes of *T. monococcum*. All these and other facts demonstrate the strong dominance of certain genes in ordinary as well as complex interspecific hybrids of wheat.

Amphidiploids between Species with Homologous Genomes

Most of our amphidiploids were obtained from crosses of species of wheat with non-homologous genomes. However, we also have amphidiploids from crosses of species with homologous genomes. Thus *T. polonicum* and *T. durum* give normally fertile hybrids in the first and subsequent generations, which show a wide range of segregation with the appearance of parental types and of new combinations. By doubling the chromosome numbers of such hybrids we obtained several years ago 56-chromosome types, which in their biological characteristics approached autotetraploids with all their defects, such as low fertility. Their fertility in the first generation was only 0.17 seeds per spikelet, while the controls had 2.78 seeds per spikelet. These amphidiploids were preserved with great difficulty. In subsequent generations the fertility of these amphidiploids increased to 0.8–0.9 seeds per spikelet.

Equally low is the fertility of the amphidiploids *T. vulgare-durum*. These amphidiploids were obtained as early as 1940, but so far we have not reported them in full. The amphidiploids *T. vulgare-durum* (2n = 70) were obtained in the following combinations: *T. durum* var. *melanopus falcata* 2111 – *T. vulgare* var. *lutescens* 0.62; *T. durum* var. *hordeiforme* "Arnautka" – *T. vulgare* var. *lutescens* 0.62; and *T. vulgare* var. *milturum* s553 – *T. durum* var. *hordeiforme* s"Arnautka." In all of these combinations the existence of plants with 70 chromosomes in somatic cells (that is the sum of the diploid numbers of the two species of wheat) has been ascertained cytologically. The fertility of these amphidiploids turned out to be very low: spikes had only solitary seeds. At the present time only the first two amphidiploids have been preserved in the pure state. The third amphidiploid was pollinated (without emasculation) by the highly fertile amphidiploid *T. vulgare-Timopheevi* (2n = 70) and is being preserved in the hybrid state. The first two pure amphidiploids vary greatly in their fertility in the fifth generation grown in the current year; the fertility in single plants was 0.5, 1.3, 1.4, 1.7, 1.8 and up to 2.6 seeds per spikelet. The presence of plants with spikes having a fairly large number of grains permits improvement by selection for this character. The hybrids between the two 70-chromosome amphidiploids have on the whole higher fertility, though they also show considerable variation in the number of seeds, from 1.6, 1.8 to 2.2 seeds per spikelet.

The production of such a large number of amphidiploid types of wheat places before us the problem of further work with these types for the solution of a whole series of general theoretical and practical questions. At the present time our work with amphidiploids is proceeding in the following directions:

(1) Selection by the usual mass and individual methods.

(2) Crosses between different 56-chromosome types and selection of the best combinations from the hybrid populations.

(3) Crosses between various amphidiploids with non-homologous genomes for the purpose of obtaining segregation of the *T. Timopheevi* genomes and creation of 42- and 56-chromosome types from hybrids obtained from crossing various 56- and 70-chromosome types among themselves.

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SHORTER ARTICLES AND DISCUSSION

CURLED–BLISTERED WINGS, A DIGENIC CHARACTER OF *DROSOPHILA MELANOGASTER*

THE inheritance of most of the mutant characters found in Drosophila and other animals and plants (with the exception, of course, of those determined by multiple factors) depends upon a single primary gene. The action of this gene may be influenced by many other genes and chromosome aberrations acting as enhancers, suppressers or dominance modifiers. A few cases are known of digenic characters, ones which depend upon the simultaneous presence of two different, non-allelic genes, neither one of which has any phenotypic effect alone. The two classic examples of digenic characters in *Drosophila melanogaster* are vortex (Bridges and Mohr, 1919) and ski (Clausen and Collins, 1922).

Vortex, characterized by the presence of pits or vulcano-like protrusions surrounded by whorls of microchaetae on the mesothorax medial to the wings, depends upon the simultaneous presence of a second chromosome recessive gene (later shown to be an allele of dumpy, 2–13.0) and a third chromosome recessive gene, locus 40.4. Bridges and Mohr found several other modifying genes with specific effects. Ski, in which the wings were bent upwards at their tips, resembled curled and jaunty. It was found to be produced by two factors, a recessive third chromosome gene (si-3) at locus 46.5 and a dominant second chromosome gene (Si) at locus 36. Si/+ si-3/si-3 gave a slightly upturned wing; Si/Si si-3/si-3 gave a very strongly curled wing.

In February, 1940, flies were found in a tetraltera stock (Villee, 1942) which had wings curled up and strongly blistered. A stock of these was established and tests later showed that the character was digenic, depending upon a second chromsome recessive and a sex-linked dominant.

From the original curled blistered flies several lines were set up, some of which bred true for curled blistered, others continued to produce some wild-type flies from matings of curled blistered × curled blistered. The symbol "cybs" was assigned tentatively to the factor producing the curled blistered phenotype. Crosses of cybs ♀ × Oregon wild type ♂ and Oregon ♀ × cybs ♂ both gave all wild-type offspring, showing that curled blistered is not a

simple dominant. Some crosses of cybs ♀ × cybs ♂ gave offspring all of which were cybs; other crosses of cybs ♀ × cybs ♂ gave: ♀♀ all cybs, ♂♂ ½ cybs, ½ wild type, indicating that a sex-linked factor was involved in the production of the curled blistered phenotype.

Localization of Curled Blistered

Female curled blistered flies from the stock breeding true for the character were mated to male S/Cy, D/Sb flies and F_1 males were back crossed to cybs females. The resulting offspring included 251 ♀♀ and 223 ♂♂ Star Dichaete: 158 ♀♀ and 176 ♂♂ Star: 137 ♀♀ and 174 ♂♂ curled blistered: 156 ♀♀ and 189 ♂♂ Dichaete curled blistered. This proved that the main factor for curled blistered is located in chromosome II.

Curled blistered was next crossed with bs (2.–107.3). The F_1 were all wild type, therefore cybs is not an allele of bs. When curled blistered was crossed with px (2–100.5), the F_1 were all phenotypically curled blistered. This indicated (1) cybs is an allele of px, or (2) the px stock contains an allele of cybs, or (3) px or some other gene in the px stock alters the dominance of cybs. Two facts support the first of these three possibilities: (1) the same result was obtained when cybs was crossed to other px alleles derived from different sources and (2) the crossover tests described below.

Reciprocal Back Crosses

Additional proof of the digenic nature of curled blistered was obtained from reciprocal back crosses. Crosses of cybs ♀♀ × +/cybs ♂♂ gave 621 ♀♀ and 633 ♂♂ wild type: 481 ♀♀ 526 ♂♂ cybs. Crosses of +/cybs ♀♀ × cybs ♂♂ gave 171 ♀♀ 221 ♂♂ wild type: 137 ♀♀ 62 ♂♂ cybs. Using the hypothesis that the curled blistered phenotype is produced by a sex-linked dominant (Cb) and a second chromosome recessive allele of px (px^{cb}), these crosses become Cb/Cb px^{cb}/px^{cb} × +/Y px^{cb}/px^{cb} and Cb/+ $px^{cb}/+$ ♀ × Cb/Y px^{cb}/px^{cb} ♂. On this hypothesis the expected numbers of the first cross are 1 curled blistered ♀: 1 wild ♀: 1 curled blistered ♂: 1 wild ♂ and the expected numbers for the second cross are 2 curled blistered ♀♀: 2 wild ♀♀: 1 curled blistered ♂: 3 wild ♂♂. The numbers obtained approximate these ratios but do not fit them exactly because curled blistered flies are less viable than wild type and the curled blistered classes in each case are lower than expected.

Localization of the Second Chromosome Factor

To localize the second chromosome recessive gene, the dominants Lobe^2 eyes (L^2, 2–72.0) and Minute bristles (M(2)173,2–92.3) were used. Crosses were made of curled blistered ♀♀ × Lobe^2 ♂♂ and F_1 ♀♀ were back crossed to curled blistered ♂♂. The male offspring of this cross were not counted because both the Lobe and the wild classes would contain some crossover and some non-crossover flies. Among the females were 420 curled blistered and 473 Lobe flies (non-crossovers) and 133 curled blistered Lobe and 152 wild (crossovers), a crossover value of 24.2 per cent. Crosses of curled blistered ♀♀ × M(2) 173 ♂♂ and F_1 ♀♀ back crossed to curled blistered ♂♂ gave the following female offspring: 431 curled blistered: 454 Minute (non-crossovers) and 35 curled blistered Minute: 44 wild (crossovers), a crossover value of 8.1 per cent. These values placed the second chromosome curled blistered gene at locus 100.4, and indicated that it was allele of px (100.5), so it has been given the symbol px^{cb}.

Localization of the First Chromosome Factor

The recessive genes yellow (y, 1–0.0), white eyes (w, 1–1.5) and carmine eyes (cm, 1–18.9) were used to determine the locus of the sex-linked dominant involved in the curled blistered phenotype. Crosses were made of curled blistered ♀♀ × yellow ♂♂ and F_1 ♀♀ were back crossed to curled blistered ♂♂. Among the offspring were curled blistered, yellow, wild and curled blistered yellow. Since crossover and non-crossover classes could not be distinguished among the female offspring or among the yellow or wild males, only curled blistered males (non-crossovers) and yellow curled blistered males (crossovers) were counted. There were 56 curled blistered ♂♂ and 8 yellow curled blistered ♂♂ among the offspring, which gives a crossover value of 14 per cent. between y and Cb. Crosses of curled blistered ♀♀ × white ♂♂ and F_1 ♀♀ from this cross mated to curled blistered ♂♂ gave 41 curled blistered ♂♂ and 6 white curled blistered ♂♂ among the offspring, a crossover value of 12.7 per cent. Similar crosses with carmine gave 78 curled blistered ♂♂ and 5 carmine curled blistered ♂♂ among the back-cross offspring, which gives a crossover value of 6 per cent. These values place the first chromosome dominant gene Cb at about locus 13.

Other Crosses

A further analysis of the curled blistered stock showed that it contained the same alleles of ebony (3.70.7) and rough (3.91.1) balanced by an inversion similar to In 3RC found in the parent tetraltera stock.

Another cross, the results of which support the digenic hypothesis of the inheritance of curled blistered was made as follows. Curled blistered females from the true-breeding stock were mated with males phenotypically wild type obtained from the curled blistered stock which did not breed true. The offspring, both male and female, of these matings were all curled blistered. This can be explained if the genotype of the females was Cb/Cb px^{cb}/px^{cb} and the genotype of the males was +/y px^{cb}/px^{cb}.

Summary

The curled blistered character depends for its expression upon two genes: a second chromosome recessive, px^{cb}, found to be an allele of px (2–100.5) and a first chromosome dominant Cb, located about 13 units from the left end of the X chromosome. Either of these genes alone produces only wild-type flies.

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OCCURRENCE OF PIEBALD SPOTTING IN A WILD HOUSE MOUSE

Numerous investigators in the past have reported the occurrence of various recessive genes in wild house mice. However, in a discussion of spotting pattern Dunn and Charles (1937) make the point that only a few mutant genes have been obtained directly from the wild type and these all with small effects such as blaze, and tail or belly spots. For this reason and because of the natural interest that is expressed in such observations, it seems desirable to report this particular case.

In April, 1943, a wild agouti mouse and a litter of six individuals was collected from the greenhouse in the rear of the Zoology Building at College Park. The female was typical agouti in color, with the exception of the tail, which was spotted with white. The tail had a white ring 7.0 mm in extent, 44.2 mm from the basal end. This ring was followed by an agouti-colored area 3.0 mm in extent which separated the white band from a second but smaller ring 4.0 mm in extent. This second band was in turn separated from a white tail tip of 10.5 mm by an intervening agouti area 6.1 mm in extent. The entire litter of six reached maturity and consisted of one female and five males.

Since the animals were collected in an attempt to develop a stock of wild agouti mice, the female of the litter was mated to the largest of her brothers and the others were discarded. The two animals used for this mating were typically agouti in color, except for a white tip at the tail of each, the one in the female measuring 3.0 mm and that of the male measuring 6 mm in extent. The first litter from this mating (No. 301) included five individuals, four agouti and one agouti with spotting which appeared to be piebald in character. The occurrence of the spotted individual led immediately to breeding tests on the original female, which fortunately had been retained. These tests are described below.

Experimental Data

The wild female was first crossed with a male of the C_3H stock and a single litter was obtained, five in number and all agouti in color without tail spots or white hairs any place on the body. Two pairs were made from this litter, only one of which survived to produce offspring (the other pair and the C_3H male being killed accidentally as the result of a break in a steam pipe). In the first litter from this pair (No. 401) there were six individuals, five agouti and one spotted agouti. The second litter was made up of six agouti and three spotted agouti animals.

As the C_3H male died, as mentioned above, the wild female was then mated with a brown male from the thirteenth generation of an inbred strain developed by the author through brother $\times$ sister matings. This particular male was selected because it was known to be homozygous for the S gene, and further, a previous breeding record was available. This latter mating produced

three litters, consisting of six, eight and four individuals, respectively. From these eighteen agouti mice it was possible to make seven brother × sister matings, numbered No. 601 to No. 607 inclusive. All seven of these matings have had more than three litters apiece, but the spotting factor has appeared in the homozygous condition in the offspring of only two of them, No. 601 and No. 603. A summary of the results obtained in these two cases is presented in Table 1.

TABLE 1

SUMMARY OF LITTERS FROM NUMBER 601 AND NUMBER 603

Mating	Total number individuals	Agouti	Black	Cinnamon	Spotted Agouti	Spotted Black
601	19	9	6	1	2	1
603	25	8	4	2	6	5

Before any further genetic tests could be made the wild female died from natural causes, as far as could be determined. The total number of mice obtained to date in the F_2 generations from the several matings of this female are summarized in Table 2.

TABLE 2

SPOTTED AND NON-SPOTTED MICE IN F_2

Mating number	Total offspring	Number spotted	Number non-spotted
301	24	8	16
401	15	4	11
601	19	3	16
603	25	11	14
Total	83	26	57

This summary does not include the litters produced by the brother × sister matings related to No. 601 and No. 603 in which the spotting factor did not appear in the homozygous condition. While the number of mice observed is too low for any statistical analysis, it is of interest to note that the results are rather close to what would be expected mathematically, assuming that the F_1 generation consisted of individuals heterozygous for the character in question. It is not known in all cases whether the individuals forming pairs numbered 602, and 604 to 607 inclusive are homozygous or heterozygous for this character, but breeding tests are in progress to determine this fact.

In October, 1944, six piebald mice were obtained from the

Jackson Memorial Laboratory through the courtesy of Dr. G. D. Snell. The two males obtained were crossed with six spotted females from the F_2 group summarized above. The four females obtained were crossed with the only available spotted male from the F_2 group. In the first case (cross of piebald males from Jackson Laboratory on F_2 females), nine litters have been obtained for a total of fifty-nine mice all of which are spotted. The four piebald females from the Jackson Laboratory have had only two litters comprising a total of eleven spotted mice.

In order to make a further check, one of the males from the Jackson Laboratory was crossed with the female from mating No. 301 and the other was crossed with the female from mating No. 603. In the first case two litters have been obtained having a total of eleven mice, six of which are solid color and five are spotted. In the second case one litter has been obtained consisting of four spotted, three non-spotted and one accidentally killed before sufficient hair had developed to determine its appearance.

On the basis of the experimental results here reported, it appears justifiable to assume that the factor for piebald spotting (s) was carried in the heterozygous condition by the wild female in question.

Discussion

In any report of the occurrence of a recessive gene in wild stock, certain questions naturally come to mind. First of all, the question may be asked as to whether the original female was actually wild. As far as behavior was concerned, this particular female would be considered wild. She buried herself under the litter when approached, cried loudly when picked up and constantly attempted to bite. The present F_2 generation, which should be considered at least partially tame, behave much like wild mice. They have without exception constructed nests underneath the litter. They bite when picked up, and retreat to the farthest corner of the nest when any one attempts to pick them up or handle them in any way. This behavior has continued even though they are handled at least every other day.

The possibility of the escape of any of the mice of our colony with subsequent mating with a wild mouse may be excluded for two reasons. First, prior to the capture of this female all the mice in our colony were being weighed daily and it is definitely

known that all of them, including new-born litters, were accounted for daily. Secondly, we know that none of our mice at this time or previously have ever carried spotted genes.

Naturally, the possibility that the wild female may have acquired the spotting gene from a parent which had escaped from some one and by chance mated with a wild mouse can not be positively excluded. However, it seems unlikely for several reasons. It is believed that the present mouse colony is the first one to be maintained on the campus, and to the author's certain knowledge it is the only one since 1930. Since the university is located in a rural community and is, moreover, well removed from private dwellings, it is highly unlikely that such a mating would occur. To assume such an occurrence would require an extension of the chain of probabilities much further than would be necessary than to assume the occurrence of spotting in wild stock.

Dunn and his associates have recently completed a rather complete survey of the entire question of spotting in mice (Dunn and Charles, 1937; Dunn, 1937; and Dunn, MacDowell and Lebedeff, 1937). According to these workers we have several possibilities for spotting in mice: (1) s—piebald; (2) "k" genes which may cause 3 to 35 per cent. dorsal white in the absence of s; and (3) W—dominant spotting which in conjunction with certain recessive modifying genes, m(W), produces spotting. The latter type it is believed may be dismissed in this case as none of the data available gives evidence in support of the occurrence of the W gene.

It appears to the author that the major question involved is whether the wild female carried the s gene or some combination of modifying factors which would produce spotting in the absence of s. Reviewing the evidence presented above it seems more likely that the gene s is the one involved. The spotted mice obtained from this female showed without exception white belly, considerable white on the face and very large white areas on the dorsal surface. At the same time, the spotted patterns show sufficient variation for one to strongly suspect that modifying genes are also present.

One question that remains unanswered at this time is the significance of the tail spot which has appeared in a rather erratic fashion in some of the self-colored individuals resulting from the crosses mentioned above. Whether it represents a character

similar to tail tip pigmentation as reported by Grüneberg (1936) or is a sign of the presence of modifying genes similar to the "k" genes as reported by Dunn and Charles (1937) has not been determined.

Appreciation is expressed to Professor S. O. Burhoe for numerous suggestions in regard to this problem.

Summary

The occurrence of a wild agouti mouse bearing the factor for spotting is reported. On the basis of available evidence from genetic tests, it is concluded that this represents the occurrence of the gene for piebald spotting (s). Reasons for concluding that this represents an occurrence of a recessive gene in wild stock rather than the result of a chance mating with some domesticated stock are given. It is suggested that modifying genes may also be present, but the actual determination of the presence of such genes has not been made.

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